THE ENGINEER

A Seven-Day Journal

Report on Transport Helicopters

At the end of last week, the Ministry of Civil Aviation published the first report of the Inter-departmental Helicopter Committee, which was appointed in August, 1948, to investigate the commercial prospects of the helicopter as a form of internal air transport. The Committee considered evidence submitted from the B.E.A. Helicopter Experimental Unit and from three separate working parties set up to examine technical equipment required for helicopter operation at night and in inclement weather, the physical characteristics of helicopter landing areas, and some other aspects of an administrative nature. The report is divided into six main sections, the first of which reviews the present status of helicopter development. This section also contains evidence from the design authorities of the four leading firms engaged on the manufacture of helicopters. The report says that the manufacture of transport helicopters is "still in an early stage," and that with one exception present machines are too small for public transport. It also expresses some concern at the defects which have come to light in the rotor systems of all but one of the machines so far flown. Nevertheless, the Committee is satisfied that present progress and future trends show considerable promise. A belief shared by every witness, and a conclusion of the Committee, is that all transport helicopters should possess at least two engines. In the section devoted to the operational characteristics of the helicopter it appeared to the Committee that services should be of the range 50-300 miles, of high frequency, directly between city centres, and of not less than ten passenger capacity to be economic. The type and extent of navigational aids required, economic aspects and the field of operation of the helicopter are dealt with in other sections of the report. The conclusions of the Committee are listed at the end of the report. Amongst them it is suggested that a ten to twelve-passenger machine should be in service by 1954 and a twenty-passenger craft by 1958.

Industrialists to Assist in the Rearmament Programme

In the House of Commons, on Monday last, the Minister of Supply was asked if he was taking any steps to strengthen the higher levels in his organisation to deal with industrial problems arising from the re-armament programme. Replying in the affirmative, the Minister said that he had been fortunate enough to secure the services of Mr. S. W. Rawson, managing director of John Brown, Ltd.; Mr. George Briggs, assistant managing director of Tube Investments, Ltd.; and Mr. W. C. Puckey, director and general works manager of Hoover, Ltd. He then announced that Mr. Rawson had been appointed Director-General of Machine Tools; Mr. Puckey, the Deputy Director of Supplies (Aircraft) Production; Mr. Briggs, the Deputy Controller of Supplies (Munitions) Production; and Mr. E. W. Senior—the commercial director of the British Iron and Steel Federation and chairman of George Senior and Sons, Ltd.—chairman of the Steel (Rearmament) Advisory Panel. Mr. Rawson joined the Tees-side firm of iron and steel makers, Bolckow and Vaughan, Ltd., early in the First World War, and, after passing through all the departments, became its secretary in 1926. He joined John Brown and Co. in 1934 and became the firm's managing director in 1949. During the last war he supervised, on behalf of the Ministry of Aircraft Production, the construction and installation of heavy plant. Mr. Puckey served his apprenticeship with the Cosmos Engineering Company, which was later absorbed in the Bristol Aeroplane Company, Ltd. He joined Hoover, Ltd., as works manager in 1935 and became a director in 1944. During the war he served on the Industrial Panel of the Ministry of Production and the Ministry of Supply Production Committee. Mr. Briggs was an apprentice at the works of Vickers, Ltd., Sheffield, and before the 1939–45 war was a director of the English Steel Corporation. In 1939 he was seconded to the Ministry of Supply (Iron and Steel Control) as Director of Forgings and Castings. Mr. Senior became managing director of George Senior and Sons, in 1929, and in 1938 was appointed chairman of the Sheffield Forge and Rolling Mills Company. In 1940 he became a member of the Committee for Alloy Steels for Aircraft and in 1941 was appointed general director of Alloys and Special Steels, Iron and Steel Control. In 1942 he became director of Steels Division, Raw Materials Mission, Washington, and after serving on various other bodies became Controller of Ball and Roller Bearings in 1944.

Retirement of Mr. B. C. Curling

In October of this year, Mr. B. C. Curling will retire from the secretaryship of the Institute of Marine Engineers, after thirty years' service. Bernard Charles Curling was born at Rochester, Kent, on October 15, 1886, and served an engineering apprenticeship in His Majesty's dockyard at Chatham. After gaining further experience in his profession, he joined in 1911 the firm of George Kent, Ltd., as chief estimator, and successively became chief draughtsman and technical business manager. In 1919 he was appointed commercial manager and secretary to Kitchen's Reversing Rudder Company, and two years later became assistant secretary to the Institute of Marine Engineers, eventually succeeding Mr. J. Adamson as secretary in 1930. Throughout his period of office Mr. Curling has devoted all his energies to the advancement of the Institute. He has seen the membership nearly trebled and witnessed the great extension of the scope of its activities and influence, particularly since the grant of the Royal Charter in 1933. Among his other activities Mr. Curling has represented the Institute on the Councils of the Association of Special Libraries and Information Bureaux and the British Society for International Bibliography, acting as honorary secretary of the latter body during the war years. He will be succeeded by Mr. J. S. Robinson, M.A., who is the present assistant secretary. Mr. Robinson, who is thirty, was educated at Repton School and Jesus College, Cambridge, and was appointed to his present post three years ago.

Institute of Marine Engineers' Annual Dinner

The annual dinner of the Institute of Marine Engineers was held in London on Friday last, March 9th, and was attended by over 1000 members and their guests, under the presidency of Sir A. Murray Stephen. Sir Amos L. Ayre proposed the toast of "The Lord Mayor, the Sheriffs and the Corporation of London," and dwelt upon London's part in the early development of marine engineering, giving, as an instance, the "Victory," which was built for Captain J. Ross in 1829 and equipped with paddles driven by a small steam engine. The Lord Mayor of London, in his reply, mentioned his interest in the river as Admiral of the Port, and spoke of the influence exerted by the Institute in stimulating engineering progress and thus assisting British trade. In giving the toast of "The Royal and Merchant Navies of the British Commonwealth," Sir E. Julian Foley recalled the price paid in men and tonnage during the World War and praised the magnificent achievement of shipowners and shipbuilders in replacing the lost ships by 1950. Vice-Admiral Sir Michael M. Denny responded and appealed for officers to join the R.N.R. and for help to be given to those R.N. officers seconded to merchant ships. Discussing the defence programme, he mentioned that one-quarter of the Navy Vote would be devoted to the advancement of marine engineering and he deplored the shortage of qualified men for research, design and production. The present state of full employment in industry, he said, meant that there would be an inescapable reduction in things not concerned with defence. He concluded by saying that it was essential for our merchant ships to operate freely over the world's trade routes and that the Royal Navy must be strong enough to provide security for the Merchant Navy proceeding on its lawful occasions. "The Institute of Marine Engineers" was proposed by Sir Gilmour Jenkins, whose theme was the relationship between Government and the marine industry. The President, Sir A. Murray Stephen, replied for the Institute, and after commenting upon the steady increase in membership, stressed the urgent need to amend the tonnage regulations, which he labelled as archaic. To-day, he said, the benefits gained by the smaller size and reduced weight of engines were completely nullified because the space gained remained empty of cargo.

The Factory Inspector's Report

The annual report of the Chief Inspector of Factories, reviewing the year 1949, was published at the end of last week by H.M. Stationery Office. Like its predecessors, it contains observations on a number of subjects, including industrial development, accidents and their prevention, industrial diseases, hours of employment, and welfare arrangements generally. The report says that the number of industrial accidents reported in 1949 was 192,982, of which 772 were fatal. As there has been little fluctuation in employment figures, the accident totals show a welcome improvement on those of 1948, the decreases being 4 per cent for non-fatal accidents and 10·3 per cent for fatal accidents. Broadly speaking, the report comments, industrialists are paying increasing attention to the safety, health and welfare of their workers. It is realised that the provision of a minimum standard of safeguards and amenities which might comply with the letter of the law is not all that may be desired, and the Chief Inspector has concluded that there is a growing willingness on the part of many firms to look more to the spirit of the requirements of enactments and to aim at a better measure of compliance than is comprised in just a bare legal minimum. Steady progress is reported in the improvement of conditions in ironfoundries, particular reference being made to cleanliness, flooring, "good housekeeping," temperature, lighting, colour painting, welfare amenities, washing facilities, clothing, and dust and fume removal. On hours of employment, the report notes that, during 1949, over the greater part of industry the standard working week remained at forty-four hours in five days, but that overtime was worked in many factories, especially since devaluation gave renewed impetus to the export drive.

Manufacture of Deep Drawing Steel*

By R. W. EVANS, M.Met.

No. II—(*Continued from page 309, March 9th*)

Process of Manufacture

Raw materials.—It will be evident at the outset that, ideally, only the purest raw materials should be used in deep drawing charges, and, indeed, one may state that half the art of making the steel satisfactorily is to charge the proper pure raw materials. Steelmakers who have low sulphur fuel, low sulphur and phosphorus pig iron, low residuals in scrap and good quality lime and fluorspar should have no difficulty in producing the highest grades. Without these materials production becomes progressively more difficult and conversion more costly.

Effect of Sulphur on the Fuel.—The practices subsequently described cover furnaces fired with mixed coke-oven+blast-furnace gas, with tar+pitch creosote mixture, with coke-oven gas+pitch creosote mixture, and with fuel oil normally containing 2·2 per cent S. The tar+pitch creosote mixture contains 0·8 per cent sulphur.

Table I shows pit sample analyses of consecutive heats made with the three fuels, the weight of charge in all cases being about 73 tons. With the low sulphur fuels the slag weight is approximately 17 per cent of the charge weight, and with the high sulphur fuels about 25 per cent. In the latter case time is sometimes lost in trying to reduce the sulphur, but this is an extremely rare occurrence, both with mixed gases and with pitch creosote mixture; it can be said that under the low sulphur fuels the sulphur problem is practically non-existent.

Table I—*Comparative Pit Analyses Made with Three Fuels*

Cast No.	C, per cent	S, per cent	P, per cent	Mn, per cent	Ni, per cent	Cu, per cent	Sn, per cent
Mixed coke-oven and blast-furnace gas							
C.1756	0·055	0·023	0·012	0·28	0·055	0·082	—
C.1757	0·060	0·028	0·015	0·30	0·068	0·072	—
C.1758	0·065	0·026	0·012	0·31	0·074	0·158	0·024
Pitch, creosote and tar							
F.115	0·060	0·027	0·019	0·35	0·040	0·047	0·012
F.116	0·060	0·029	0·018	0·31	0·082	0·079	0·018
F.117	0·050	0·030	0·012	0·30	0·055	0·074	0·024
Fuel oil							
W.68	0·070	0·032	0·011	0·30	0·090	0·150	0·012
W.69	0·065	0·031	0·014	0·32	0·068	0·144	0·030
W.71	0·060	0·035	0·010	0·33	0·090	0·140	0·024

In the case of high sulphur fuels there seems little doubt that most of the sulphur is absorbed during the melt, and the longer this period, the more sulphur is absorbed. The pick-up is greatly accentuated by poor combustion conditions—for instance, shortage of combustion air, which tends to give a long comparatively slowly burning flame, with a lower intrinsic flame temperature. It is believed that the sulphur is present in oil as H_2S and that this compound in contact with hot oxidised steel scrap will cause a rapid absorption of sulphur. Where the oil is sufficiently finely atomised and there is plenty of combustion air, H_2S is oxidised to SO_2 and possibly SO_3 before contact with scrap; these radicles do not so easily dissociate, and thus yield less sulphur to the scrap.

Further, there is evidence that a hotter flame is produced by pitch creosote mixture than by fuel oil, so that taking everything together, the cost of conversion is affected considerably by the difference between these two fuels. Mixed gas operation has just this one virtue—low sulphur steel—but otherwise, in comparison with liquid fuel, has little to recommend it, particularly when the coke-oven gas is relatively high in hydrogen and low in hydrocarbons.

Pig Iron.—Low sulphur is essential and sulphur elimination is helped by a relatively high manganese content, both in the blast-furnace and the open hearth. It is not wise to specify too low a silicon content, as this often results in a sulphur rise, due to too nice a temperature balance in the blast-furnace. Phosphorus must be as low as possible in order to keep slag volumes reasonable. An iron containing about 0·6 per cent Si, 0·05 max. S, 1·25 per cent Mn, is preferred as it gives the blast-furnace manager, with a reasonable burden, a chance to keep the sulphur down to the lowest limits. Most pig irons contain practically no Ni, Cu or Sn.

Scrap.—Scrap should, if possible, contain not more than 0·10 per cent of Ni and Cu separately, and it is essential that wagons which are said to contain low Ni and Cu scrap do, in fact, do so, because scrap is a difficult material to sample. It is extremely troublesome to prepare everything and to control a deep drawing charge down in carbon, only to find in the end that the Ni and/or Cu are too high to make the grade. It is, of course, also necessary to get the scrap in through the door of the furnace; light scrap should be bundled to promote quicker charging and melting. This leads to more consistent melting out which is a vital necessity for this grade of steel. If Ni and Cu are running high in scrap, more pig iron (if available) can be used to dilute it which results in a higher input cost.

Limestone, Lime and Fluorspar.—Fluxes should be low in sulphur. No trouble will be experienced with limestone, but lime requires watching, as it absorbs all the sulphur from the coal required to burn it; 0·25 per cent sulphur should be the maximum, otherwise it is possible to be adding more sulphur to the slag with lime than it contained before feeding started, which, as an effort to reduce sulphur, is doomed to failure. Lime burnt with blast-furnace gas should contain not more than 0·10 per cent. It should be in fairly small pieces with the minimum of dust, because the dust generally contains much more sulphur than the lump.

Fluorspar is a vexed question; excellent quality can be bought at a price. Many use the common quality in the belief that there is no commensurate gain from the low-silica grade.

In the actual making of a deep drawing steel heat, practices naturally will differ; indeed, in one shop practices vary with the different fuels. The following points are considered important.

In order to reduce to a minimum the sulphur pick-up, the burner should be relatively level, say, 8 deg. to the horizontal during the charging and melting down periods. A steeply inclined flame tends to reach and envelope the scrap before combustion is sufficiently completed.

The level flame also helps to avoid its impingement off the scrap on to the roof. When the bath is level, the back end of the burner may be raised to provide a greater contact with the bath. Using Kraus atomisers, this practice uses for melting on 80-ton furnaces about 250 gallons oil per hour and about 4 lb steam per gallon. Steam is supplied at 100 lb per square inch, oil slightly higher and at a temperature of 180 deg. Fah. Combustion air is 450,000 cubic feet per hour and is heated to 1150 deg. Cent. through 9in chimney type checkers.

In reasonable periods, the charge, including 40 per cent hot metal, is completed in three and a half hours, and is clear melted in about seven and a half hours, when the carbon should be about 0·35 per cent. Melting samples are assayed for Ni and Cu as quickly as possible, in order to give time to alter a pit if these elements are too high.

Table II shows typical sampling periods for the two fuels.

Table II—*Bath Samples During Refining*

Time	C	S	P	Mn	Fe in slag
Cast F.7336—Fuel, tar pitch creosote mixture					
4.55 a.m.... ...	0·30	0·034	0·036	0·17	
5.30 a.m.... ...	0·13	—	0·020	0·16	
5.55 a.m.... ...	0·11	—	—	0·13	
6.20 a.m.... ...	0·07	—	—	0·12	19·8
6.42 a.m.... ...	0·05	—	—	0·09	
Pit sample ...	0·05	0·024	0·014	0·23	
Copper=0·58%. Nickel=0·055%. Tin=0·018%					
Cast U.321—Fuel, fuel oil at 2·3% Sulphur					
5.35 a.m.... ...	0·34	0·048	0·035	0·17	
7.04 a.m.... ...	0·09	0·040	0·020	0·14	
7.30 a.m.... ...	0·08	—	—	0·10	25·0
8.05 a.m.... ...	0·065	—	0·015	0·09	
Pit sample ...	0·055	0·032	0·015	0·28	
Copper=0·126%. Nickel=0·076%. Tin=0·03%					

The flux charged is all limestone (no lime) in 6in lumps, and the aim is to melt out with as low a sulphur as possible, particularly where the sulphur content of the feed lime is high, as the addition of lime containing, say, 0·5 per cent, sulphur to a slag with only 0·3 per cent appears to have no advantage chemically, physically, or mathematically. There is no doubt that the feeding of limestone chippings in judicious amounts instead of high sulphur lime has considerable desulphurising properties; further, if this material is fed round the banks at the slag line it will help to save bank wear, but the feeding must be well judged, as limestone tends to oxidise the bath.

If the carbon is lower than 0·30 per cent at melt it is unlikely that there will be sufficient time for a brisk boil on the furnace, and it is an indication that the charge is short of heat. Time will be saved if this eventuality can be foreseen and pig charged in plenty of time. In the United States tar has been injected into the bath to provide carbon, instead of pigging back. If the carbon is over 0·30 per cent at melt then time may be lost in reducing it.

*This article is based on a lecture delivered to the Swansea Metallurgical Society, March 18, 1950.

When pig from the mixer contains more than 0·05 per cent sulphur, the change for the worse is felt to a much greater extent on the fuel oil furnaces. Using about 40 to 45 per cent of mixer iron in the charge, the carbon and residual manganese at tap will be around 0·06 per cent and 0·12 to 0·14 per cent respectively. At this time the total Fe in the slag on pitch-creosote mixture will be 16 to 18 per cent and on oil 22 to 24 per cent.

Finishing additions are 4 cwt of ordinary Fe-Mn in the bath for about ten minutes, which helps to eliminate 0·002/003 of sulphur and steadies the bath. A further 4 cwt is added to the ladle and this is the only ladle addition. Charges are tapped at 1570 deg. to 1590 deg. Cent. on the immersion pyrometer, though it is considered that the indications provided by this instrument are not nearly good enough to provide a sole indication of tapping temperature. It is necessary to have at least a 6in diameter tap hole and this is the size of pipe used for repairs.

So far the bath is clear melted in 7½ hours and refining will take approximately another 2½ hours, making 10 hours charge to tap. On the mixed gas furnaces this might be 1½ hours longer, due generally to a longer melt-down period. Fettling will average about 1 hour per charge, including bad bottom time, giving a 11-hour tap to tap period. Fettling consumption runs at 65 lb to 70 lb of dolomite per ton.

Single-stoppered ladles are used with 5½in diameter stoppers and 1⅝in bore nozzles of fireclay. Larger nozzles are preferred, but present ladle design will not accommodate anything bigger. In the United States 2½in nozzles are common, and, on heats of 200 tons capacity, they are necessary to avoid excessive skulls in ladles.

The question of ingot teeming height is very important, as it is difficult, due to ferrostatic pressure, to get a steady rimming action at, say, 78in high, the metal either tending to sink about 5in and then come up to original teeming level or tending to rise altogether. The use of a specially designed mould 46in by 28in, which enables us to teem to 70in maximum height, has increased the slabbing mill yield by 3 to 4 per cent over what was possible by teeming rimming ingots up to 78in height. No mould coatings are used, but moulds are scraped and brushed.

It takes about half an hour to teem a 75-ton charge; any aluminium required by excessive sinking of the ingots is added as shot to the top quarter of the teeming height. Free rimming is allowed to proceed for about twenty minutes, which gives about 5in rim, and the ingot is then capped with a steel plate. At the bottom of the moulds our practice includes the use of splash cans to prevent splash, and pad plates to protect the bottoms. Ingots are left on bogies for about one and a quarter hours after completion of teeming before being moved. It is considered most important that, for the best rimming results, the moulds should not be hotter than 150 deg. Cent. when teemed; hot moulds tend to give a sluggish rim, due to the slower heat transfer and rate of solidification.

This completes the ingot stage, but it is true that bad track times, bad soaking pit practices, and bad slabbing mill practice will have an adverse effect on the slabbing mill yields. As a general rule it may be stated that if (1) the cast analysis is satisfactory, (2) the slabbing mill yield is satisfactory, (3) the slab is properly processed through the hot and cold mill and allied operations, (4) deep pressing is not delayed after temper rolling, then the sheets will deep-draw satisfactorily.

Hearth Maintenance

The manufacture of deep drawing steel is exacting on both furnace structure and hearths. High temperatures have to be maintained throughout the refining stage when Fe in the slag is steadily increasing and the slag is both hot and corrosive. This is hard on the slag line and banks which should be fettled with fine material; coarse dolomite runs down the banks and thickens up the base of the banks. Also, hearths become soft towards the time of tapping, so that if there is any weakness in the form of an old steel "dog" deep down, it will tend to show itself as a bad hole, which is a prolific source of dirty steel, skulled ladles and loss of production. Making this class of steel on old or weak bottoms is a costly and dangerous pastime; it pays in the long run to replace a hearth when it starts to give continual trouble.

Monoliths containing higher MgO proportions than exist in ordinary dolomite—for instance, mixtures of magnesite with stabilised dolomite—have given improved results over the straight dolomite bottom. The best hearth of all is probably 100 per cent graded magnesite mixed with the minimum amount of basic slag and burnt-in layer by layer.

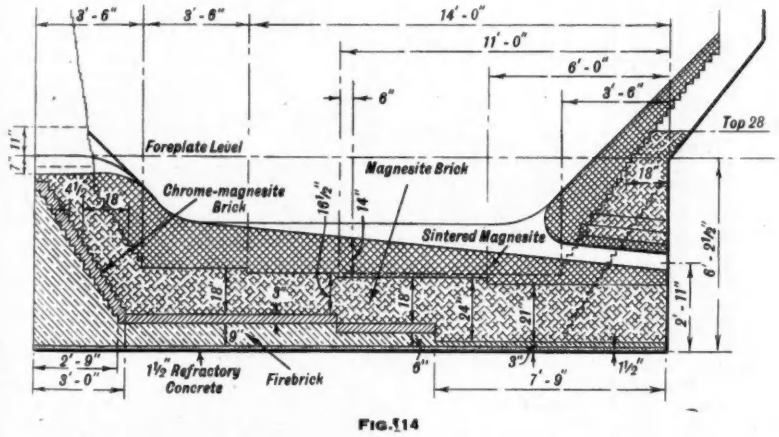


FIG. 14

Fig. 14 shows the proposed hearth for a stationary 200-ton furnace. It will be noted that a layer of chrome-magnesite bricks has been placed between the magnesite bricks and the firebricks. The object of this is to prevent, in the case of a very deep hole, chemical reaction between MgO and SiO_2 of the firebrick at the very high temperatures which might occur.

Furnace Design and Repair

Furnace design should include sloping rear walls, generous uptake and flue areas and free passages through the checkers. Eighty-ton furnaces in the practice described have a total uptake area of 48 square feet each end and their checkers are built of chimney design with 9in by 9in vertical holes. They are steam blown once a week at three levels, and steam blowers buried in the floors of the flues are used to keep the flues free. All this is of great importance when firing with pitch creosote mixture. Front walls are of chemically bonded Cr-Mag bricks intersheeted.

In order to maintain steady maximum rates of production not less than 90 per cent furnace availability should be the aim; for instance, with twelve furnaces installed 10·8 on average should be in commission.

Table III—*Analysis of 90 per Cent Availability*

90% availability = 45 weeks operating out of 50, i.e., 5 weeks or 35 days per year are available for repairs

This is allocated as follows:—

2 general repairs at 9 days	18	
+2 warming up periods at 2 days	4	
		22
2 part repairs at 5 days	10	
+2 warming up periods at 1½ days	3	
		13
		35 days

Checkers would be changed on one general repair only, that is, once a year at most. On the other general repair they would probably require retopping.

Table III shows an analysis of 90 per cent availability. Some United States plants are working at 95 per cent and over, i.e., Inland Steel Company, with twenty-four furnaces in the shop maintain an average of over twenty-three in operation. At Gary they have averaged fifty furnaces in operation with fifty-three built.

Regularity of operation is essential to good deep drawing practice—delays in charging, addition of hot metal, or of feed additions, or delays for fuel off due to patch repairs lead to greater hearth wear and promote both hard and soft melts, all of which exaggerate the delay. In order to trace these delays it is essential to set standard times for each component period of the charge-to-charge time. Thus, for a deep drawing steel the standards might be:

	Hours
Charging	3½
Melting	4
Refining	2½
Fettling	1
	11

A delay is booked for anything longer than the above periods, and such delays are analysed right down to a crane part if necessary, so that recurring sources of trouble can be rectified. It is a golden rule with this system that every delay must be accounted for by the man on the job.

Lay-out of Iron and Steel Works for Production of Deep Drawing Steels

It has been seen that the manufacture of deep drawing steels is a specialty which requires pure raw materials and regularity of operation. These ideas affect the lay-out of the whole iron and steel plant. For instance, plenty of track room should be provided for shunting and marshalling special scrap to the loading yard, and to the furnace bay. Again, as only the finest lime should be used it will be advantageous to use blast-furnace gas in firing lime kilns. Hot metal should be low in sulphur and phosphorus and regular in composition; this calls for big furnaces working on moderate slag volumes, which calls for a maximum use of imported ore. On this account the plant should be so situated that the ore remains waterborne till it is transferred by transporter to the blast-furnace bunkers. Low sulphur and phosphorus coking coal also should be at hand.

Comparison with the United States

When we compare our plants and resources with what are available in the United States,

we may congratulate ourselves nationally on producing excellent deep drawing steels. As the price of scrap and pig iron are much nearer each other in the United States, they are anxious, wherever sufficient pig iron is available, to increase its proportion in the charge up to about 60 per cent. For liquid fuel firing this gives the optimum rates of melting and refining, and also has the inestimable advantage of diluting down the tramp elements, part of which recirculates as domestic scrap to help further the position. As American pig iron contains on average 0·2 to 0·3 per cent of phosphorus, there is no objection to using high hot metal, particularly as the strip mill operators are getting sulphurs in the pig iron around 0·035 per cent. It is necessary under these conditions to carry only about 9 per cent of slag, and if more than this is carried flushing is practised during refining so that excess unwanted constituents are eliminated from the system. In addition, they are using fuel oil of 0·5 to 0·8 per cent sulphur and actually become worried if the sulphur rises to 1·2 per cent. Under all these conditions they undoubtedly produce the best deep drawing steel in the world, though, in order to cope with the ever-increasing severity of the pressing operations, they are gradually replacng rimming steels with aluminium-killed qualities.

The Future

Finally, what of the future? The scope of use for deep pressed steel sheet seems to be almost limitless, and we may be sure that as more uses are devised, so the steelmaker is in for more headaches, until some day a customer will think up a deep draw which no steel will stand, physically, chemically, mathematically, theoretically or practically. However, metallurgical research goes along hand in hand with the technique of steel production, and hitherto the steelmaker has never failed to give a quality which has been shown by metallurgical research to be possible even though difficult.

In our struggle to maintain and improve the position, we have resources which are as yet largely untapped—oxygen from the atmosphere, for instance. It has been quite possible to produce a 200-ton charge in five hours, using oxygen for enrichment of combustion air and for carbon reduction. This is at the rate of 40 tons per hour and the use of oxygen is only in its infancy!

The limit to the tonnage producing rate of the furance under these conditions is the life of the brick structure. Already the all-basic furnace seems to be looming up as an answer to this particular problem.

And so, having solved the technical problem of making steel quickly, we will be up against the problem of assembling and charging the solid materials fast enough to maintain the vastly increased melting speeds. This will be a tough nut to crack, but a solution will be found; adequate scrap preparation will contribute largely to it.

A Rotary Chart Translator

By G. A. FLINT, B.Sc., and J. G. LEE

THE engineer of to-day, no less than the administrator, has his paper problems. Circular charts from recording instruments relating to every twenty-four hours, for example, are robust and easily filed, but they quickly accumulate to an alarming degree, and make reference and summary difficult. A device to overcome this difficulty by enabling such charts to be re-plotted automatically on to a continuous time base has recently been developed by two members of the staff of the British Iron and Steel Research Association.

On this instrument the time base is, at the same time, very much condensed and it is possible to obtain for detailed examination a "translation" of, say, one month's records conveniently on a chart about 2ft 6in long. Figure 1 shows an example where this has been done for the volume and pressure records of the blowing engine of a blast furnace.

It was for this purpose, in fact, that the device was first designed. When the authors were engaged on an investigation into the pressure and volume requirements of blast air for blast furnace blowing, it was found necessary to examine fluctuations in these quantities and blast temperature over a considerable period, in some cases as much as six to twelve months. It was realised that to carry out this examination it would

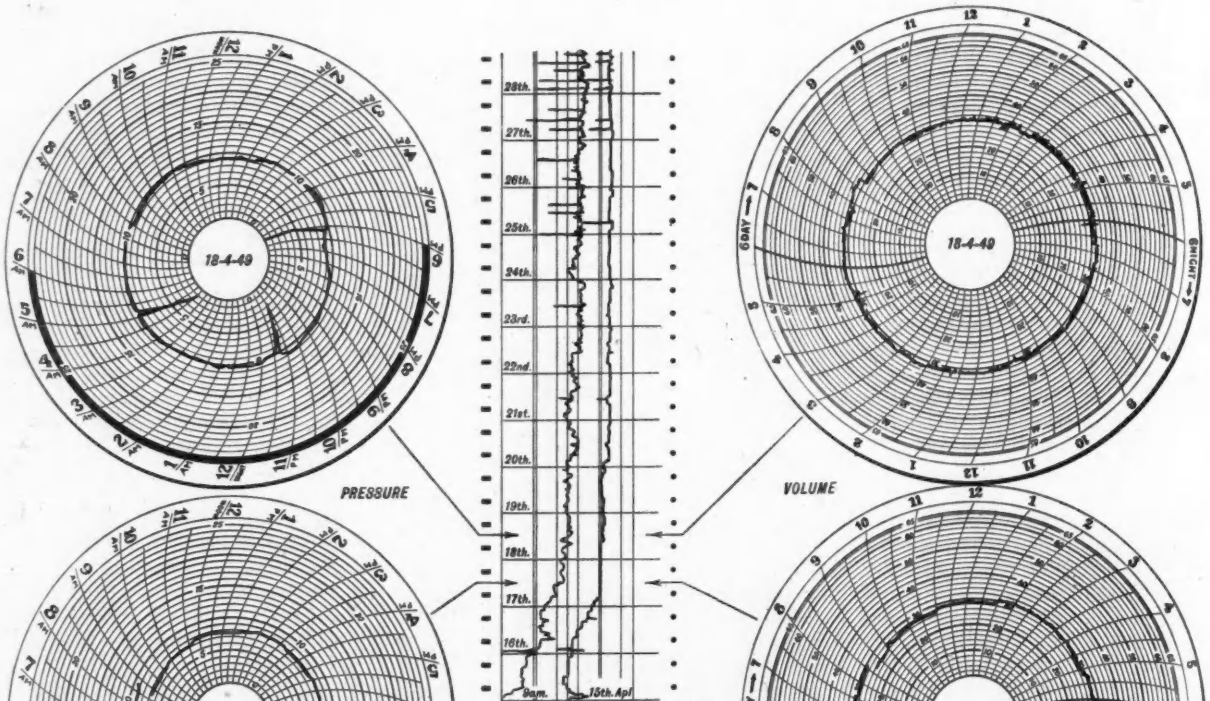


FIG. 1—CIRCULAR CHARTS OF PRESSURE AND VOLUME OF BLAST FURNACE BLAST TRANSLATED ON TO STRIP CHART

be necessary to re-plot the existing twenty-four-hour charts on to a continuous time base. The labour involved in doing this by usual graphical methods was prohibitive, and it was therefore decided to develop an instrument which would simplify the operation.

Once teething troubles had been overcome it was found that six months' records could be dealt with in about seven or eight hours, though it was found advisable to use two operators in two-hourly spells if fatigue and loss of efficiency was to be avoided. On this basis a degree of accuracy of some ±3 per cent was achieved, which compared well with that of the original recording instrument.

A diagrammatic sketch of the instrument is shown in Fig. 2, and a detailed drawing in Fig. 4. The appearance of the instrument is illustrated in Fig. 3.

Principle of Operation

The operator follows with a stylus the inked line recorded on the circular chart,

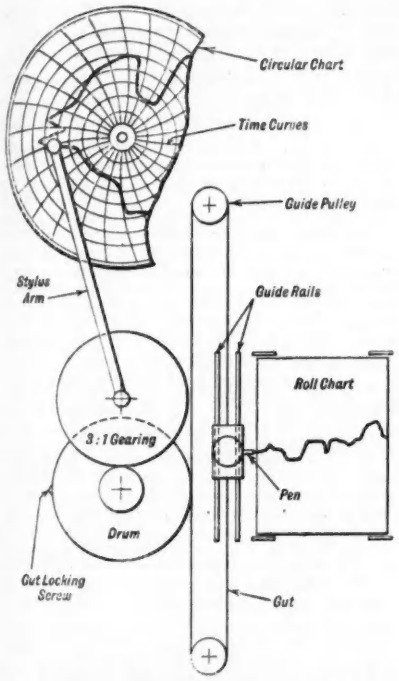


Fig. 2—Diagrammatic Sketch of the Instrument

which is rotated at a suitable speed. The stylus spindle is coupled through a suitable step-up gear to a cylindrical drum, about which is wrapped a flexible driving band of gut. As the angular movement of the stylus arm spindle is a direct function of the variable recorded and its rotation imparts a linear motion to the length of gut, this motion is again a direct function of the original variable. The gut is therefore attached to a pen mechanism running on parallel slides and the movement is recorded on a continuous roll chart, giving a trace exactly similar to the original inked line.

The translation of the time base is carried out by means of a direct mechanical coupling between the turntable on which the rotary chart is mounted and the sprocket of the strip chart rolling mechanism. This is effected by driving both from a common motor. The scale of the time base is fixed by so choosing the gear ratios in relation to the chart sprocket diameter that one revolution of the original chart (i.e., twenty-four hours) corresponds to the required length on the strip chart (e.g., 1in equivalent to twenty-four hours).

Various problems arose as the machine took shape, and the following criteria became apparent.

Design Criteria

Chart Complexity.—In order to deal with charts of varying complexity, the turntable speed must be variable. A variable speed motor having the speed control in an accessible position must be used.

Reversibility of Chart.—Should the stylus be allowed to overrun the point on the circular chart at which it is desired to stop the turntable it would be necessary to wind back the chart. Winding back would also be necessary if for any reason the recorder pen failed to work or if a mistake were made in translation. The motor must therefore be reversible.

Stylus Arm Radius.—Since the radius of the recording pen arm varies with different types of recorder and also since the pen-arm pivot may be in different positions relative to the chart even for pens having the same radius, the length of the stylus arm and the position of its pivot must be adjustable.

Pen Operating Quadrant.—It may be necessary to use charts from recorders having the pen operating in either the top or bottom left-hand quadrant of the chart and therefore the stylus arm must be capable of being used on either side of the chart centre.

Chart Direction.—The chart may be graduated in the clockwise or anti-clockwise sense. Since the strip chart-winding mechanism is unidirectional it must be possible to reverse the turntable without changing the direction of this mechanism.

Co-ordination of Charts.—The operator must be able to set zero positions of both charts together. Because of the large variety of charts which would have to be dealt with having either linear or non-linear scales it was decided to use blank chart rolls and calibrate these from the charts being translated.

Chart Centres.—Variable size centre bushes must be provided in order to deal with variations in the centre-hole size of the circular chart.

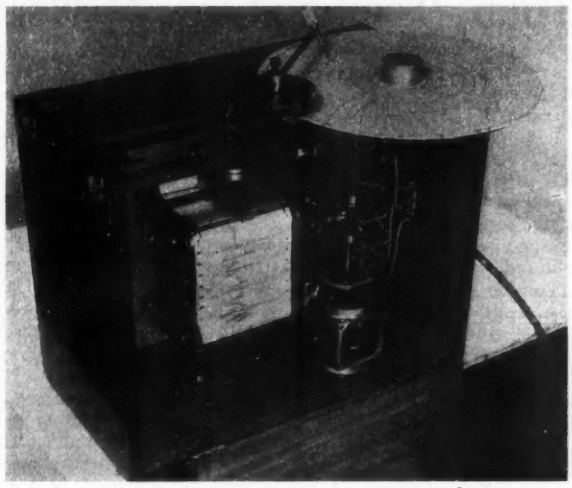


Fig. 3—Translator in Operation

Design Data

The instrument shown in Figs. 3 and 4 was designed to the following requirements:

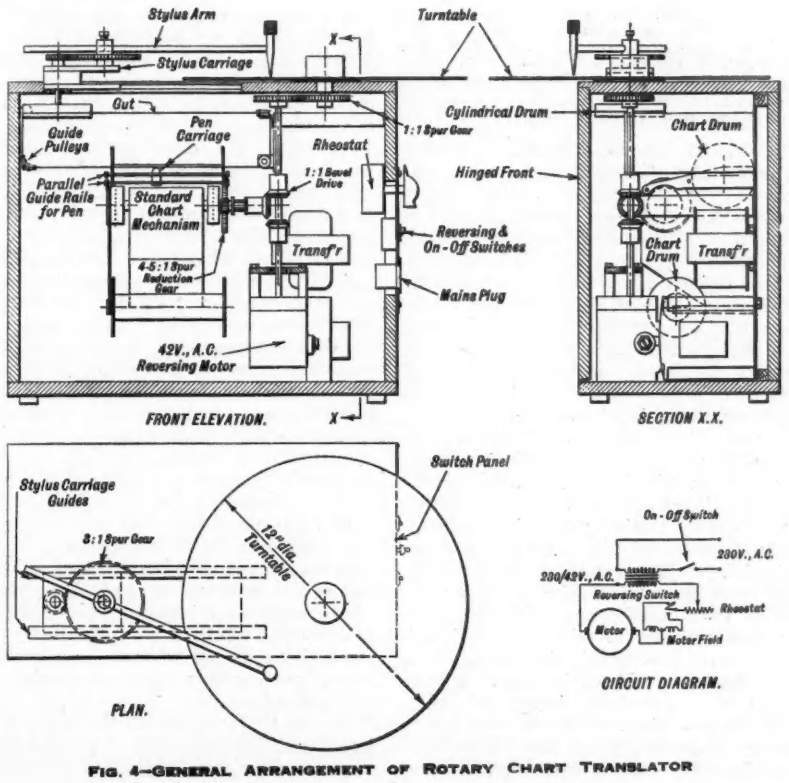


Fig. 4—General Arrangement of Rotary Chart Translator

Chart turntable speed to vary from 0 to 3 r.p.m.

Stylus arm radius to vary from 4¼in to 8in.

Maximum chart diameter, 11¼in.

Maximum angle of sweep of stylus arm, 47 deg.

Movement on linear chart, 3½in.

Minimum size of centre-hole of chart ¼in.

Based on these figures the instrument proved capable of dealing with a very wide range of charts from many different makes of instrument; in fact, no chart has yet been encountered which is not covered by these requirements.

High Temperature Steels and Alloys for Gas Turbines

IRON AND STEEL INSTITUTE

No. II—*(Continued from page 314, March 9th)*

THE afternoon session on February 21st opened with a discussion on "Special Casting Techniques," as dealt with in the following papers (Group V), which were introduced by Dr. T. A. Taylor (National Gas Turbine Establishment).

CENTRISPUN HIGH-ALLOY-STEEL AERO-ENGINE COMPONENTS

By A. E. Thornton and J. I. Morley

The main features of the centrispinning process are outlined and results of mechanical tests on representative castings are given in Part I. Part II is a detailed statement of the investigation of centrispun castings of steels containing chromium 18–25, nickel 8–14 per cent, with small additions of one of the elements, titanium, niobium or tungsten.

CENTRIFUGAL STEEL CASTINGS FOR GAS TURBINES

By J. Taylor and D. H. Armitage

A description is given of the method of manufacture, and of the inspection procedure, applied to attain mechanical tests at least equal to those of the highest grade wrought products.

INVESTMENT CASTING OF NOZZLE GUIDE VANES

By H. E. Gresham and A. Dunlop

Modern development of the old "lost wax" process is described, factors affecting dimensional accuracy discussed, and creep properties of investment-cast alloys are given.

PRECISION CASTING OF TURBINE BLADES

By E. R. Gadd

Production of turbine blade castings by the "lost wax" precision casting method is described, casting defects and their causes are detailed, and information given on high-temperature fatigue properties of the cast alloys and on a laboratory method of determining resistance to thermal shock.

Mr. P. H. Lawrence (B.S.A. Precision Foundry, Birmingham), in opening the discussion, said, with reference to investment casting, that one suitable method of casting a mould would appear to be to do it centrifugally, or rather by semi-centrispinning, as defined in the paper by Thornton and Morley. This was done in the U.S.A. and on the Continent, but he was not decided as to whether, from a production angle, it was a satisfactory method. Investment casting was a good way of making intricate shapes, especially in alloys difficult to work otherwise, but economical production demanded care at every stage of the process. He wondered whether the authors of the papers on investment casting had devised any laboratory method of testing the suitability of waxes, or had had any experience of plastics. He had found that plastics of the polystyrene type, while giving the advantages of quick production, suffered from a degree of warping or distortion which is greater than that obtained with a wax. Conditions of mould drying and of sand grading were extremely important. One of the biggest troubles in the foundry in keeping production going at a high level was to keep the grading right. With regard to thermal shock, the surface condition of the blade, apart from grain size of the material, had some effect. A polished blade gave better thermal shock resistance than one having the normal surface condition.

Mr. Z. Z. J. Kosarski (Sheepbridge Castings, Ltd.) agreed with Mr. Thornton as to the greater freedom from internal defects of castings from metal dies, but he thought that the mechanical properties were, on balance, in favour of castings produced in refractory moulds, provided that they were really sound. The lower ductility of castings produced in refractory moulds (itself of the order of 20 per cent) was more than offset by the something like 10 per cent higher proof stress. To avoid the confusion existing in the present nomenclature, he suggested the use of the names "centri-die" and "centri-sand" castings for castings produced in permanent metal moulds and in refractory moulds respectively. In suggesting a dividing line at a diameter of 30in between vertical and horizontal spinning, Mr. Thornton, he thought, was referring to his own equipment. There was really no dividing line at all.

Mr. M. M. Hallett (Sheepbridge Engineering Company, Ltd.) agreed with Mr. Thornton as to the greater cleanliness of castings produced in metal dies, but doubted the evidence of his photomicrographs. He suggested that the relative freedom from inclusions of the casting from the metal mould was due to the simpler shape of the die, true unidirectional solidification and a higher spinning speed resulting in a more efficient centrifuging action, and he asked if the spinning speeds of the two types of mould had, in fact, been the same. He questioned the need for tungsten in the 25 : 12 chromium-nickel steel and asked whether the authors had any actual creep data on that basic type of steel, with and without tungsten.

Ir. H. J. Meerkamp van Embden (Philips Lamp Works, Holland) said that much more use was made of cast turbine parts in America than in this country, and asked whether there was any special reason for this. In their own products (which had nothing to do with turbine blades) they had been able to make use of the advantages of casting, which became more pronounced when expensive or rare materials were being employed.

Mr. A. Dunlop (Rolls-Royce, Ltd), replying to Mr. Lawrence, said that they had carried out laboratory tests on waxes, but their significance was not always clear. The final test of any new wax was to make a pattern of the actual component in which they were interested and to check its quality by measuring. He agreed that the polystyrene type of pattern showed more distortion than wax patterns.

Mr. A. E. Thornton (Firth-Vickers Stainless Steels, Ltd.) said that if metal handling arrangements were satisfactory, and the form of the casting lent itself to directional solidification, there was everything to be said for centrifugal instead of static casting; but, in his experience, that combination of circumstances did not often occur. The terms suggested by Mr. Kosarski had long been used in America, and, sooner or later, might be adopted here. In reply to Mr. Hallett, who had agreed that a centri-die casting was much more reliable than a centri-sand casting, he said that, having regard to the conditions to which these castings were subjected, the most reliable method of manufacture should, in his opinion, be used, irrespective of very small differences in the physical properties of the material. The photomicrographs to which reference had been made were taken from castings from a composite mould, half of which was composed of metal and the other half of refractory. In this composite mould, constant conditions obtained for liquid steel, casting temperature, casting speed, pouring technique and heat-treatment. The only variable was the mould material.

Dr. E. C. Rollason (Murex Welding Processes, Ltd.) acted as rapporteur for Group VI, "Welding and Machinability Aspects," which consisted of the following papers.

WELDING OF HEAT-RESISTANT ALLOYS IN SHEET FORM

By H. E. Lardge

A brief description of the sheet-metal parts of a typical jet propulsion unit is given followed by notes on the characteristics of the material used which affect welding. The use of the oxy-acetylene torch and of carbon, argon and metallic arc processes are then discussed, followed by a description of the techniques developed for the resistance processes of spot, stitch and seam welding, as applied to gas turbine work, and of the electrical resistance hot riveting process for use with stainless steel rivets.

WELD METAL PROPERTIES AND WELDING CHARACTERISTICS OF TWO AUSTENITIC STEELS USED FOR GAS TURBINE ROTORS

By E. Bishop and W. H. Bailey

Suitable welding electrodes have been developed for steels G18B and R20, each capable of depositing weld metal of composition similar to that of the parent metal. Steel G18B was found to have excellent welding properties; R20 first presented some difficulties which were subsequently overcome. In both cases the creep properties of welded butt joints made with the appropriate electrode were slightly superior to those of the wrought steel.

MACHINING AUSTENITIC AND FERRITIC GAS TURBINE STEELS

By K. J. B. Wolfe and P. Spear

The paper contains a survey of the problems associated with the machining of heat-resisting and creep-resisting steels, and the results of the work of the B.S.A. Group Machinability Research Laboratory on these types of material.

Dr. Rollason, in introducing the papers, referred to a number of points on which further information would be desirable, in particular, the effect of stress concentrations at the edge of resistance welds which might lead to fatigue failure under dynamic loading, the most suitable preheating temperature for the 11 per cent cobalt, complex austenitic steel G18B (a preheat of 600 deg. Cent. had been advocated, but Bishop and Bailey stated that the lower the interpass temperature the better), the mechanism of the micro-cracking of welds of R20 (19 : 13½ : 1½ Cr-Ni-Nb) hot-spot machining and cutting by a combination of spark discharge and electrolytic action for which claims had been made in Russia.

Dr. H. G. Taylor (British Welding Research Association) directed attention to a recently published account of work on hot-spot machining, carried out at the Battelle Memorial Institute, which showed the great advantage of the method for difficult high-

alloy materials. Some years ago tests on these lines had been carried out with promising results by the British Welding Research Association, but the matter had not been followed up. In connection with seam welding, Mr. Lardge had referred to the importance of effective cooling to reduce distortion. The rate at which welding was carried out was also important. With materials of low thermal conductivity, the heat flow away from the spot was slow, and if the speed of welding was fast there was the possibility that the materials would not be held together long enough and separation would occur.

Mr. G. C. E. Olds (British Thomson-Houston Company, Ltd.) remarked that an important condition which must apply for land and marine gas turbines was that the weld metal should maintain high ductility and toughness for long periods at the operating temperature. He noted that elongation and reduction of area of all-weld-metal G18B had fallen considerably after only one hour at 650 deg. Cent., and similarly with R20. It would be interesting if the authors could give figures for longer times. With weld metal of 18 : 8 chromium-nickel stabilised with 1 per cent of niobium, sound structure and good mechanical properties were obtained, but sigma embrittlement occurred after a long period at 650 deg. Cent. By the addition of 2 per cent of copper the advantage of a ferrite-containing weld metal could, to a certain extent, be retained while the risk of embrittlement was much reduced.

Mr. R. R. Roberts (Research Laboratory, British Thomson-Houston Company, Ltd.) gave further information about the copper-bearing 18 : 8 weld metals successfully used on a welded rotor for a marine gas turbine. Whilst the fully austenitic weld metals cracked (though low in silicon) compositions with 5 per cent delta ferrite gave sound welds. They were thus led to choose duplex copper-bearing deposit electrodes, and as a result of a number of test welds between forged discs of F.C.B. (T), he agreed with the authors that such precautions as drying of electrodes, low interpass temperature, no preheat, &c., led to the production of very sound welds.

Mr. H. J. Goldschmidt (B.S.A. Group Research Centre) showed a tentative ternary diagram for Fe-Nb-Si supporting the view of Bishop and Bailey that the micro-cracking of R20 weld metal was due to the presence of high silicon and the formation of a Fe-Nb-Si compound.

Professor Dr. Ing. F. Rapatz (Gebr. Bohler and Co., A.G., Austria) said that hot cracking was due to the weakness of intergranular substances. The presence of ferrite lightened the stress on the grain boundaries. To avoid cracks even in pure austenitic steels it was necessary to have a low silicon content and a high manganese content and to avoid acid steel.

Mr. J. I. Morley (Brown-Firth Research Laboratories) referred to experience, not with G18B, but with the closely related steel 326, which confirmed that G18B was crack-resistant, and suggested that there were other ways of overcoming the difficulty of cracking in fully austenitic welds than by introducing small amounts of ferrite. This type of steel was, however, subject to room-temperature embrittlement arising from long exposure at elevated temperatures, and he asked the authors whether G18B was different in that respect. With reference to the 18 : 13 chromium-nickel-niobium steel, he mentioned instances of heavy pad deposits of low silicon content which had all cracked. The theory of low silicon was not a practical answer to the problem. Better practice seemed to be to rely on ferrite which conferred increased ductility at 1250 deg. Cent., though too much ferrite caused embrittlement due to sigma phase formation. Ferrite in small quantities, however, minimised embrittlement by dispersing carbide from the austenite grain boundaries. It also tended to reduce the creep strength, but offset this disadvantage considerably by increasing the rupture-ductility of the weld metal.

Mr. W. Huber (Sulzer Brothers, Ltd., Switzerland) said that in the Sulzer gas turbine plant built for the Weinfelden electric power station, with an output of 20,000kW, all four gas turbine rotors were of welded construction, three being made from G18B steel. The welded rotor had advantages over the solid rotor. The material could be more thoroughly forged and single discs better tested. If one disc showed a defect it was a small matter to replace it, but the replacement of a one-piece rotor required a great amount of work, time and cost. A welded rotor could be built up from different types of steel, the best material being used only for discs on the high-temperature side. A turbine with welded rotor might be lighter, smaller and perhaps cheaper than when a solid rotor was used. Great importance had to be attached to heating up time. Heating up periods of fifteen minutes were almost as detrimental as a very sudden temperature rise. The welded G18B rotors in the Weinfelden plant were run at 650 deg. Cent. Inspection during shut-down periods disclosed no faults whatever, and Mr. Huber said that he had full confidence in the manufacture of welded rotors.

Mr. H. E. Lardge (Joseph Lucas (Gas Turbine Equipment), Ltd.), in reply to Dr. Taylor, gave details of speed of welding which was very important from the production aspect. He commented on the high quality demanded of the sheet metal work of the combustion equipment. Further information was required for the benefit of designers about the fatigue strength of resistance welds on thin sheet metal work at elevated temperatures.

Dr. E. C. Rollason said that, in spite of the improved resistance to micro-cracking given by the special R20 electrodes, the trouble was not always eliminated. The ternary compound was probably a contributary factor, but it did not explain all the cracking. He had found cracking in applying the 18 : 13 alloy with no niobium at all. Heterogeneity and internal stresses were important factors. He regarded micro-cracking as a fundamental feature of the austenite grain boundaries above about 1200 deg. Cent., and its avoidance as dependent on reducing the energy of the grain boundaries. The special R20 electrode was one line of attack, and the other was to produce a weld metal with a controlled amount of ferrite (3 to 7 per cent). This might be done by the use of molybdenum when complete stability against intercrystalline corrosion was not necessary, or, as had already been mentioned, by copper in the niubium alloy. The copper-containing weld metal suffered a loss of ductility when heated at 850 deg. to 1000 deg. Cent., so stress relieving at 900 deg. Cent. should not be done with that type of alloy if rewelding had to be carried out.

(To be continued)

The Industrial Economics of Metallurgy*

By A. J. MURPHY, F.I.M.

THIS country has seen a most critical situation arise during recent months in connection with most of the non-ferrous metals of major importance. If I speak of the United Kingdom particularly, it is only because the details of developments here come so regularly and so forcibly to my notice. I am well aware that the circumstances and trends in other parts of the world are very similar.

We have seen the supply of copper and zinc in relation to demand become so precarious that drastic curtailment of releases of the metals has become necessary; manufacturers who, seeking an alternative, turn to aluminium find that even established users of the metal must contrive to reduce their consumption substantially below the rate recorded over a certain period in 1949. Lead is now so difficult to come by that motorists are warned to lock the bonnets which cover the precious batteries in their cars, and lead roofs are stripped by predatory citizens not, as formerly, for the silver content, but simply for the value of the lead, while tin has settled down as a four-figure metal in pounds per ton.

It may be said that so far as the metallic resources are represented by mineral ores they are more properly the affair of our sister institute, the Institution of Mining and Metallurgy, and I would not dispute this. But the most complete knowledge of the reserves of metal in the ground, of the rates of production, and of the economics of mining, would still leave untouched factors of immense importance affecting the availability of metal for use by the metal-working industries.

An important factor in producing the present shortages has undoubtedly been the precautionary stockpiling which has been adopted as a part of their policy by so many states. If this were the only factor, or the greatly predominant factor, it would be serious enough, since the balance of our complex industry is so delicate that even a temporary diversion of raw materials can have devastating consequences for companies and individuals far outside the circle of concerns immediately involved. It might be that a stockpiling programme could be accommodated without grave dislocation, albeit certainly at the cost of much inconvenience, if a term could be set to the period of the stockpiling. It is not the practice, however, for stockpilers to announce the size of the stock which they aim to create, and the activity remains an influence of uncertain intensity and duration.

The most superficial study of statistics of production and consumption of the principal non-ferrous metals since the beginning of the century reveals a shifting of the balance between supply and demand which is producing a disequilibrium increasing in an exponential manner. Looking at the long-term trend and thinking of developments in decades rather than years, we see influences of an apparently permanent and

*Institute of Metals, March 13th. Presidential address. Abstract.

potent nature compared with which stockpiling is merely a ripple in a powerful stream. The basic forces spring from three elements: first, the increasing population of the world; secondly, the essentially exhaustible, non-renewable characteristic of mineral resources; and thirdly, the world-wide demand for higher standards of living. The first and third forces—that is, increasing numbers and expanding desires—have not the quality of inevitability of the second, but they appear to be essential features of civilisation as we understand it, and unless we are to plunge deeply into philosophical and social-anthropological speculation we may regard them as permanent.

There is no need to quote large collections of statistics to depict the scale and rate of movement. The population of the world, which was 1009 millions in 1845, is now 2300 millions, and is increasing by 20 millions each year—that is, every two and a half years there is added to the human inhabitants of the globe a number equal to the present population of the United Kingdom. Over the same period the annual rate of production and industrial application of iron and steel has increased five times as fast as the population; since 1880 the consumption of copper has increased tenfold and that of zinc five-fold. We see, therefore, that imposed on the increase in numbers of consumers is a steep rise in consumption per head. The effect of a movement towards a higher standard of living has been illustrated by the calculation that if the consumption of copper per head throughout the world rose to be one half of that in the United States, the tonnage of new copper required annually would be 10·9 millions, compared with the present world production of 2·4 million tons.

A situation like this presents a problem to all whose interests are related to those of metallurgical industry. In one way or another it affects all classes of our membership, and it does so by posing three questions:

(1) What can we do to improve our supplies?

(2) How can we make better use of what we have?

(3) What substitutes can we use in place of the metals which have become difficult in supply?

The first takes us at once into the fields of prospecting and mining, extraction and refining. The Institution of Mining and Metallurgy has for long devoted much of its activities to these matters, and we may well be content to leave them in their hands, not overlooking our interest in some aspects of refining, such as the thermodynamics of metal-halide reactions, which are rather far removed from process metallurgy as ordinarily understood.

Making better use of what we have means, in the first place, an examination of the efficiency with which we employ our metals. Here it is not a question of mechanical efficiency, for instance, by economy of weight in aeronautical structures, but rather the avoidance of extravagance in the quality of metal used in particular applications, the criterion of quality which is relevant in this connection is the difficulty of replacement in stock and not necessarily the usual test of chemical purity, although the two are often synonymous. The use of a higher grade of a metal than the application, or the method of manufacture, technically demands, or the unnecessary use of one metal in place of another more freely available, and likely to remain so, is metallurgically inefficient.

There is another direction in which we must look if we are to secure the most effective outlay of our stores. This involves inquiry into the fate of all the metals, which, once having been won from the earth, have survived in the metallic form or as compounds easily reduced once again to metals. These comprise the great corpus of metals in current service in an infinity of forms and also the stock of metals which are temporarily out of active use, the worn-out or obsolete or redundant articles constituting old scrap and the surplus from manufacturing processes such as turnings, clippings and furnace residues. This is the field of secondary metals, which has been relatively neglected by scientific metallurgy.

A variety of causes has probably been responsible for this neglect. One may well have been a reluctance of metallurgists to study the leavings and contaminated side-products of industry and society. Another deterrent has been provided by the complexity of many secondary metals and the difficulty in deducing the effects of the simultaneous presence in an alloy of several impurities, quite apart from the influence of non-metallic inclusions. Whatever the reasons for the lack of interest in secondary metals on the part of metallurgists, it is clear that this indifference cannot persist when we realise how great and vital a part secondary metals play in the economy of metallurgical industry. In copper, 38 per cent of the metal consumed in 1948 was of secondary derivation, in aluminium the proportion was 30 per cent, in lead 45 per cent, and in zinc 28 per cent. We know that the steel-making industry takes 55 per cent of its metal input as scrap.

Substitutes

The third question which I suggested we must consider was: What substitutes can we use in place of the metals which have become difficult in supply? In one sense the answer in respect of any specified application is easily given: it calls only for an analysis of the properties essential to the performance of the service, a reference to the tabulated data for the classes of material offering a *prima facie* case for consideration, and then a selection in the light of availability. Even within such circumscribed terms of reference as these the treatment of the problem may be rather involved; for one thing, where a usage has existed for a long time it is often by no means easy to deduce which characteristics of the metal are indispensable for the application.

It is only dealing with the first stage of the problem of substitution if we confine ourselves to discussing interchangeability on the basis of equivalence or similarity of physical characteristics. We must pass from this step to consider the position as regards supplies of the technically acceptable substitute: will they be only temporarily easier and will they be exposed to risks of interruption or curtailment or to fluctuations in price to which the industry has not been accustomed and for which it is not organised? Is the alternative peculiarly sensitive to contamination, does it involve an unduly large ratio of metal cast to finished product, will it demand troublesome changes in manipulative plant? Only after the patient unravelling of these and similar interwoven threads can the possibility and appropriateness of a substitute be assessed.

My object in making this very brief review of the subject of resources is to discuss what service this Institute can perform in this connection for its members and, indeed, for the community. In the course of our normal activities hitherto we have given little attention to these matters, although our rules do not exclude them explicitly or by implication from our interest, and although they are of the liveliest concern to the great majority of our members in whatever capacity they have to deal with metals. Future readers of our *Journal* for the year of 1950 will find no reflection in our papers and discussions of the fact that the non-ferrous metals industry has entered a phase of crisis in its supplies of material which is likely to have a profound effect on its immediate fortunes and its ultimate pattern of development. I feel it is wrong that, as an Institute, we should give this impression of detachment from these problems which are of such vital interest to our members. It may be objected that questions of supply and demand are essentially the affair of the economist and therefore not properly brought before our Institute for discussions. But this is a territory in which economic considerations and technical metallurgical factors are most closely linked.

Think, for instance, of the factors which have to be taken into account in forming a sound judgment on the value in Britain of home-produced magnesium as a replacement for imported metals. There is the mineral resource in unlimited amount: magnesium chloride in the sea and dolomite in the Pennines, and electric power for electrolysis of the fused chloride is to be had. But the power is expensive in this country in relation to the cost in Canada and other countries with very large hydro-electric installations. Is there a point where the assurance of a supply of light metal produced at home would outweigh the disadvantage of a higher cost of production? As another example, in copper alloys we have the repercussions of the change in practice from cold rolling to hot rolling of 70 : 30 brass. While making possible a great acceleration of production, this demands a higher grade of purity of metal, and consequently the exclusion of some secondaries which could be used when cold rolling was the method used.

The examples could be multiplied by anybody who has had to assume a measure of responsibility for policy in a manufacturing concern using or producing semi-finished products of metallurgical industry. In each of these there is a metallurgical component inextricably involved with the economic: a proposal which may be attractive on broad economic grounds may fall down on account of a technical metallurgical obstacle, or a scheme impeccable metallurgically may require for its achievement economic conditions not producible at the time.

I do not doubt there are learned societies and institutions where papers are received dealing with the economic side, but I know of none in which a metallurgist would feel at home in submitting his contributions for joint discussion with the man who would say his own approach was certainly that of the business executive.

Since writing this I have come across the following passage in Rosenhain's Presidential Address in 1928†:

"There is no function of this Institute which I value more highly than that of promoting interchange of ideas and experiences between practical men and between practical and scientific men who are interested in the same subject. The Institute has done much to break down barriers that formerly hampered the progress of the non-ferrous metals industry. Men, both practical and scientific, have come to know and understand one another better and, with increasing mutual knowledge, has come that measure of confidence which is essential if men are to

† *Journal*, Inst. Metals, 1928, 39, 28.

work together profitably. I only wish that it might be possible for that understanding and confidence to grow not only deeper as between the technical man in the works and the scientific man, but that it might grow wide enough to embrace also the business man—the man who, ultimately, controls finance, and therefore is the deciding factor in determining how far and how soon the results of research are to be utilised. Even in that difficult direction the Institute has done something, and will, I hope, do more in the future."

My suggestion is that this is a field in which—while most emphatically not contemplating any curtailment of the scientific activity on which its reputation as a learned society has been gained—our Institute can perform a valuable function by providing a forum where these aspects of metal economics can be discussed. I am strongly encouraged to put forward this proposal by a study of the papers which were communicated to the conference organised by the United Nations Economic and Social Council at Lake Success in 1949, under the title of "Conservation and Utilisation of Resources." There were several papers dealing with metallic resources of the world which would have fallen appropriately within the range I envisage being covered by this new activity of the Institute. I will quote some of the titles and authors of these papers, and I commend them to your attention.

"The World Resources Situation," by Fairfield Osborn.

"World Resources and World Population," by Colin Clark.

"Critical Mineral Shortages," by H. L. Keenleyside.

"Conservation of Mineral Resources," by Donald H. McLaughlin.

"The Accumulation and Conservation of Metals in Use," by Charles White Merrill.

"The Supply and Industrial Applications of Scrap Metals," by H. J. Miller.

A valuable report of the conference by Dr. H. Sutton appeared last year in the *Metal Industry*.‡

Some of my friends may say that this would not be a new activity for the Institute, and I agree that it would certainly be within the declared aims and objects of the Institute, the two most important of which are: to promote the science and practice of non-ferrous metallurgy in all its branches, and to facilitate the exchange of ideas between members of the Association and the community at large, by holding meetings and by the publication of literature, and in particular by the publication of a journal dealing with these objects.

If it is not a new activity, so much the better. In any case, if I find any support for the idea, I propose to arrange an informal meeting of members and non-members who might be interested to take part in a discussion of a paper prepared by somebody engaged in this line of inquiry or even on one or two of the papers from the United Nations conference to which I have already referred. In the event of such a meeting proving successful, not the least of the benefits which the Institute could receive might be some additions to its membership from circles concerned with non-ferrous metals who had not previously found the Institute devoting attention to the aspects of interest to them. But more important than this would be the prospect of making an appreciable contribution to the study, and perhaps the solution, of the gravest problem which has beset non-ferrous metallurgical industry in the lifetime of our Institute.

‡ *Metal Industry*, 1950, 77, 3, 19, 35, 57.

Operating Experience with a 750kW Gas Turbine

At a general meeting of the Diesel Engine Users' Association, held on Thursday, March 15th, a paper entitled "Operating Experience with a 750kW Gas Turbine," of which the following is an abstract, was read by G. B. R. Feilden, M.A.*

It is the purpose of this paper to concentrate upon the practical aspects of operation, on the basis of experience gained during the first twelve months of endurance running of the Ruston and Hornsby 750kW gas turbine. A specification for the turbine was outlined in 1945, and envisaged a long-life unit of simple construction, having an output of 750kW and entirely free from cooling water requirements. Active design work was begun in May, 1946, and attention directed to those parts upon which least experience was available, such as the heat exchanger, the combustion system and blade vibration.

The turbine first ran under its own power in June, 1949, and started at the very first attempt without the use of the blow-off valves which had been provided in case the compressor ran into a "stall" while accelerating. After a period of thirty-three hours' testing of the gas generator section of the plant to obtain an approximate characteristic of the compressor, the output turbine was fitted and the plant was calibrated up to its full power on a water dynamometer. Subsequently the alternator and speed governor were fitted and the plant assumed its final form, and a start was made on an endurance test, which was successfully completed on September 28, 1950, the total running time being just over 1000 hours.

Design of 750kW Gas Turbine

The general arrangement of the turbine is shown in Fig. 1. The salient novel features in the Ruston turbine design, compared with previous industrial gas turbine practice, may be listed as follows:—The use of a cooled stator with segmental shrouding for the compressor driving turbine; the use of two-stage overhung disc turbine rotors for both the turbine driving the compressor and the output turbine; the use of thin-section high-temperature ducting supported kinematically within an external pressure carrying casing; the use of an epicyclic reduction gear; and the use of a "backbone" frame construction, combined with the lubricating oil tank.

The sectional drawing shows that the set has been constructed in four major units, connected by flexible ducts as follows:—The "gas generator unit" consisting of the thirteen-stage axial-flow compressor driven by the two-stage high-pressure turbine; the heat exchanger, which is flexibly supported from the main turbine frame in a pit below the plant; the combustion chambers, arranged symmetrically, one on each side of the plant; and the combined power turbine and reduction gear. The units are mutually independent, both structurally and for servicing purposes. Any one section of the installation can be dismantled for inspection without interfering with any of the other parts, the only components which require more than four hours' work for dismantling being the reduction gear and the heat exchanger.

Operating Experience

The overall performance of the turbine when operating with its heat exchanger was determined by testing the plant up to full power on a water brake. The readings obtained are summarised on the graph (Fig. 3), and it will be seen that a fuel consumption of 0·59 lb per b.h.p.-hour at full power was measured, the equivalent thermal efficiency being 23·4 per cent, which compares with the design estimate of 24 per cent. Owing to the provision of a heat exchanger and a free-running output turbine the efficiency of the plant is well maintained at part load and has been found to exceed 18 per cent at half power. The following comments are given on the performance of the various components, and they have been arranged in the order in which the air passes through the various components in the course of the operating cycle.

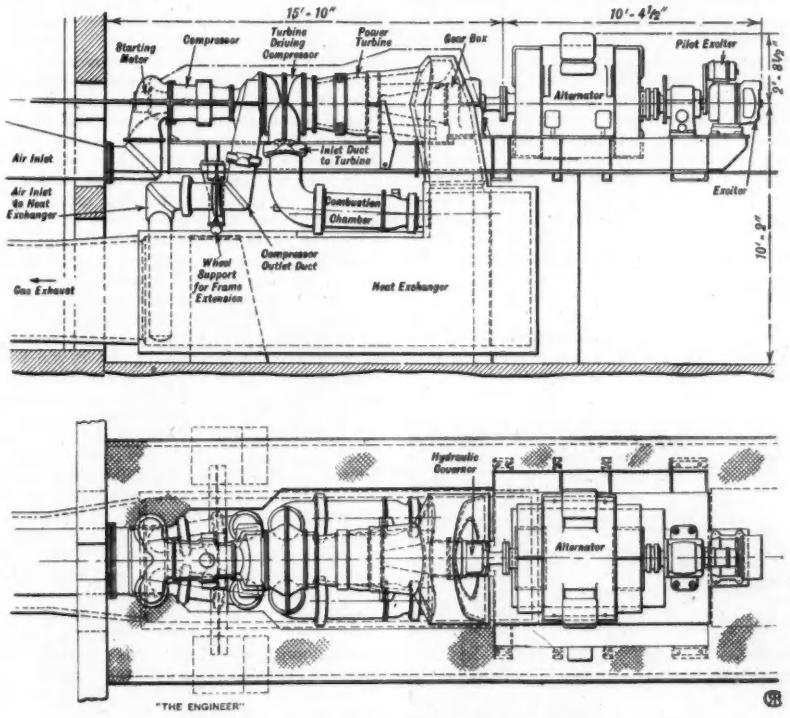


FIG. 1—*General Arrangement of 750EW Gas Turbine Plant*

Air Inlet Filter.—During the design stages little information was available regarding air filtration requirements for gas turbines. Certain gas turbines were reported to have given satisfactory performance without air filtration, while others were prone to loss of efficiency resulting from blade fouling. It was decided to follow a middle course and provide a fabric filter of the Vokes "Kompak" type, which consists of thirty-two elements, individually removable for cleaning or inspection, arranged on four faces of a cubic frame. After 1100 hours'

* Chief Engineer, Turbine Department, Ruston and Hornsby, Ltd.

operation the elements still had a substantial service life left before replacement, and it should be added that the gas turbine was operating in a typical industrial atmosphere.

An inspection of the plant at the end of the first thirty-three hours' running disclosed that a number of foreign particles had passed through the compressor, causing some damage to the leading edges of the blades. Examination of the air filter revealed that the fit of several filter elements left much to be desired, and to remedy this a modified type of filter element sealing strip was fitted. While a dry fabric filter will rembve from the inlet air all relatively large particles of dust, some blade fouling does take place. Accretions of dirt formed at the leading edges of all stages of the blading. The profile of the blading remained relatively clean, except in the first two or three stages, where deposition had been aggravated by lubricating oil which was drawn from the front bearing of the compressor. Notwithstanding the appreciable dirt deposits on the blading, only a relatively small fall in the efficiency of the compressor was measured, amounting to slightly more than 2 per cent at full power. With the present design of compressor, dirt builds up on the leading edges of the rotor blades to a certain magnitude, after which particles are thrown off by centrifugal force. The particles pass through the compressor without adhering to the blade profiles, which remain nearly clean, and it is reasonable to hope that some 5000 hours, or about one year's running, may be achieved without the necessity of cleaning the compressor blading, assuming that no leakage of lubricating oil takes place into the compressor. No attempt has been made to clean the compressor by injecting cleaning fluids while the plant is running, as the performance of the compressor has remained satisfactory without this expedient. The performance of an axial compressor may be restored nearly to its original value by passing coarsely atomised kerosene through it when running at a low speed.

Compressor.—The thirteen-stage axial-flow compressor was designed to have 50 per cent reaction blading. Forty-nine rotor blades are

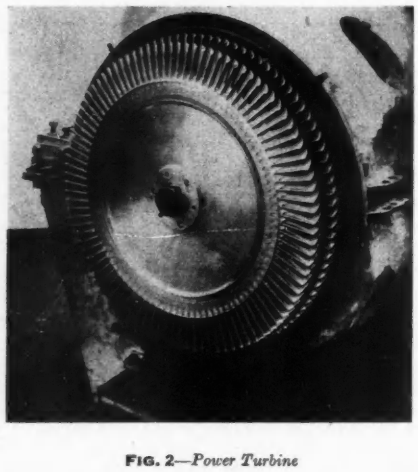


FIG. 2—*Power Turbine*

used in each stage, the blades being identical in profile throughout the compressor, but shortened in length as the high-pressure stages are reached. Similar remarks apply to the design of the stator blades between the rotor stages, but special stator blades are employed at the inlet of the compressor and at exit, to allow for the different velocity triangles applying at these points. For the initial tests compressor blading in R.R.56 aluminium alloy was fitted. It was realised that the fatigue properties of this aluminium alloy were inadequate for long life, but the aluminium blades withstood over 1000 hours' running before fractures were found in two of the twelfth-stage rotor blades. Performance measurements on the compressor showed that it was giving an efficiency of 84 per cent at full power, compared with the design estimate of 82·5 per cent, and upon establishment of this fact orders were placed for rotor and stator blades in stainless steel. The noise level from the plant is relatively low, and with the heat insulating cover in position normal conversation can be carried out alongside the plant. The noise from the installation may be divided between mechanical noise from the reduction gear and a whistle from the air inlet; no noise can be detected from the low-velocity exhaust duct.

Heat Exchanger.—In the heat exchanger 5832 tubes in "Yorkalnic" aluminium bronze-nickel alloy, $\frac{5}{16}$in outside diameter by $\frac{1}{4}$in bore, are used and arranged in nine bundles, each containing 648 tubes, 12ft long. The high-pressure air from the compressor passes through the bore of the tubes, while the exhaust gases

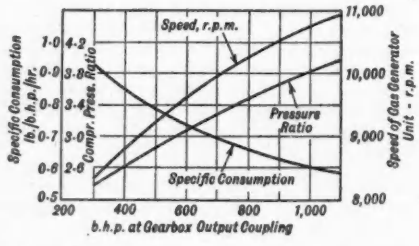


FIG. 3—*Performance of Gas Turbine with Heat Exchanger*

pass in a counterflow direction over the outside of the tubes. For securing the tubes into their headers silver brazing was adopted with "Easyflow" brazing material and flux. To remove traces of flux after brazing, the tube bundle headers were pickled in hot acid and subsequently hosed down with water. Inspection of the tube bundles after the first 33 hours' running showed that the gas inlet appeared to be in excellent condition, though some deposition of gummy carbon had taken place at the cold end. This deposit was caused by partially burned lubricating oil, which had leaked into the gas stream from the turbine lubricating system. Following the resumption of running, the gummy deposit began to flake off. This finding shows that a tubular heat exchanger, even when fitted with quite small tubes, may have some self-cleaning tendency. A further example of this effect arose subsequently, when modifications to the combustion system were being made. With one combustion arrangement an appreciable amount of smoke was visible in the exhaust, and this reacted upon the heat exchanger by forming quite heavy deposits of soft carbon at the gas outlet end, though the gas inlet end remained free from deposits. Notwithstanding the heavy deposition, the air temperature rise in the heat exchanger was scarcely affected. In fact, throughout the testing of this gas turbine it has not been possible to detect any variation in the thermal ratio of the heat exchanger when operating under a given set of conditions.

During endurance running a reduction in overall performance was noted, and it was found that serious corrosion had taken place adjacent to the header plates at the hot end of the heat exchanger, twenty-six tubes having broken away from their header plates. As a result of this failure a considerable loss of high-pressure compressor air had been taking place. The cause of failure was corrosion from brazing flux residues which had not been removed during the pickling and washing operations, and had subsequently deliquesced (i.e., absorbed atmospheric moisture), while the plant was standing between tests. Examination showed that any residues left on the cold ends of the tube bundles had been "insulated" from atmospheric air by the remains of the gummy oil deposits, and thus the residues were prevented from deliquescing and becoming chemically active. The tubes have now been secured in place by a roller expander.

Combustion System.—A twin combustion chamber arrangement was adopted, each "can" passing 10 lb per second of air. The design of flame tube was so arranged that the separate sections are kinematically supported to allow for the wide temperature variations and the use of separate sections of flame tube wall permits replacement of any section.

When tested on the turbine the section of the flame tube nearest to the fuel atomiser glowed at bright cherry red heat, and some slight modifications in the air flow through the combustion chamber were effected to shorten the flame and reduce the wall temperature in the primary combustion zone. The initial modifications consisted of fitting fuel atomisers having a narrower spray angle, slightly modifying the air flow through the primary swirler, and fitting three film cooling bands to each flame tube. These modifications reduced the wall temperature, but the quality of combustion was seriously impaired, and a tendency to smokiness was visible when the plant was developing a power in excess of one-quarter full load. This smoky combustion deposited a soft carbon at the outlet end of the heat exchanger, and hard carbon was formed in the neighbourhood of the fuel atomiser. Examination of the blades of the compressor driving turbine after running with these modifications showed that some lumps of hard carbon were lodged in the first stage of stator vanes, while other pieces had passed through the rotating blading, damaging the trailing edges of the first row, as shown in Fig. 4.

Satisfactory results were obtained finally by blanking-off one row of air admission holes in the tertiary zone, and by fitting the annular washer to blank-off the outside diameter of the swirler. This modification reduced the violence of the reverse flow in the centre of the swirler and thereby reduced the recirculation of burning oil droplets on to the swirler vanes. Fig. 5 shows the appearance of the combustion chamber "hot end" on completion of 1030 hours' running and it will be noted that there is only a light dusting of carbon on the fuel atomiser head.

Considerable trouble was experienced in reaching approximate equality in the outlet temperatures of the two chambers, due to

FIG. 4—*Damage to Compressor Turbine Rotor Blades*

differences in the output of the fuel atomisers, which developed as a result of partial blockage of the fuel passages by particles of cracked fuel, caused by heat soaking into the atomiser heads on shutting down. The difficulty was solved by the use of a spill control atomiser, developed by the Shell Petroleum Company, in which the orifice is positively shut off by means of an internal needle valve whenever the difference between the fuel inlet and spill pressures falls below a preset value. The closing of the orifice enables fuel to be continuously recirculated without any fuel escaping from the orifice, until the atomiser's surroundings have cooled to a temperature below the cracking point. The outlet temperatures of the two combustion chambers now remain within 36 deg. Fah. (20 deg. Cent.) of each other, compared with spreads of 360 deg. Fah (200 deg. Cent.) previously experienced. As a result of this experi-

ence a single combustion chamber is to be fitted to all future plants.

Turbines.—The condition of the blading in both turbines was found to be most satisfactory on conclusion of 1030 hours' running. An interesting phenomenon has been the appearance of white deposits, particularly on the power turbine blading, shown in Fig. 6. These consist of sodium sulphate and are formed as the anhydrous salt, which takes up water of crystallisation from the atmosphere on standing after testing.

To assess the efficacy of the cooling system measurements of disc temperatures have been taken by plotting cooling curves obtained with contact thermocouples which have been pressed

FIG. 5—*Atomiser and Primary Combustion Zone*

on the surface of the disc just beneath the rotor blade root, immediately after the turbine has come to rest after a prolonged period of running. While this method of measuring disc temperature cannot be claimed to be more accurate than ±20 deg. Cent., the indications so obtained are a very useful guide to the performance of the cooling system. The graph (Fig. 7) gives representative temperature readings. Without a cooling system large thermal stresses occur in the rotor every time the plant is started, and if distortion is to be avoided, it will also be necessary to "bar" the rotor round for some period after the conclusion of running. With an effective cooling system the rate of heat flow into the rotor structure is substantially reduced, and a gas turbine may be started and stopped as rapidly and as frequently as desired without ill effect. The Ruston plant has now been started over 330 times, the following being a representative timing for the operation :—

	Seconds
Starter motor engaged with resistance	0
Combustion chambers light up (compressor at 500 r.p.m.)	5
Starter motor switch full on	10
Compressor reaches 4500 r.p.m., starter motor switched off	35
Power turbine begins to revolve	45
Alternator reaches synchronous speed, governor takes control	90
Alternator synchronised with mains	150
Plant develops full power (750kW)...	6 min

Examination of the turbine blades and discs has failed to reveal any signs of distress resulting from the relatively rapid rise of gas temperature at starting, and this is regarded as a fairly conclusive demonstration of the merit of the type of cooling adopted. Similar thermal stress considerations apply to stator structures. For this reason provision was made in the design of the stator of the compressor-driving turbine to allow for rapid temperature rise of the portion exposed to the hot gases, while the temperature of the main rigid structural member is kept much lower than the gas temperature. As a result the compressor turbine stator has remained round to within 0·005in, measured in a radial direction, over the whole 1100 hours' running.

By contrast the power turbine stator, which operates at an appreciably lower gas temperature than that of the compressor turbine, was made as a conventional stainless steel casing split at the horizontal joint. Before assembly the stator was given a stress relieving treatment, but after 170 hours' running it was found that the stator had distorted by over 0·040in, measured radially, and there was some danger that a turbine blade rub might take place. In the author's opinion, distortions of this character are inevitable in split casings operating at gas turbine temperatures, unless the limitation of a very long warming-up period is accepted. A solution already exists in the cooled stator construction, which has proved so reliable for the compressor-driving turbine.

Reduction Gear.—One of the features of this gas turbine is the use of an epicyclic reduction gear having a ratio of 4 : 1 in place of the single or double helical gears currently used in steam turbine practice. The epicyclic gear was chosen on account of its compactness and because its input and output shafts are concentric. The design of the planetary system of the gear and the manufacture of the complete gearbox was undertaken by the Self-Changing Gear Company, Coventry. When the testing on the turbine was begun no trouble was experienced. After 28½ hours' running it was found that the sun wheel had slight signs of scuffing, while the driving splines inside it showed some signs of fretting. The remaining gears and the bearings were in satisfactory condition. After a further 143½ hours' running a marked increase of noise, combined with the development of some vibration, was noted, and

FIG. 6—*Power Turbine Stator Showing Crystalline Sodium Sulphate*

it was found that a serious deterioration had taken place in the condition of the sun wheel. A new sun wheel in case-hardened steel, the teeth of which were ground, was fitted, as was an improved type of oil spray for lubricating the sun wheel teeth. A further 900 hours' operation at varying loads up to a maximum of 900kW has now been completed without trouble. In future it is intended to use hardened and ground gears for the planets as well as for the sun wheel, and to take additional precautions regarding the accuracy of machining the casing.

Bearings and Lubrication System.—The compressor rotor is supported on plain bearings at its inlet and outlet ends. The shells of these bearings are in each case lined with white metal, 0·020in thick. The bearings were initially assembled with a clearance of 0·006in on the 2¾in diameter journals. After 1030 hours' running the top half shells of both the compressor inlet and exit end bearings show no markings. The bottom half shells show a slight "matting" effect, combined with burnishing at each end of the shell, the wear of the white metal being under 0·0001in. The condition of the shaft journals is also very satisfactory.

For both turbines copper-lead bearings are used, this material being chosen to provide a greater margin of safety against rise of shaft temperature after running than is given by a white metal shell. The bearing pressures are under 100 lb per square inch of projected area, so that copper-lead is not necessary on account of its high load-carrying capacity. As in the compressor bearings, the top half shell is unmarked, the original lead-tin electro-flashing being untouched. In the bottom half the flashing has been locally removed in the loaded area, but no measurable wear of the shell or journal can be detected. Thrust in both the gas generator and power turbine rotors is carried by Michell Bearings, which are designed to operate with a pad bearing pressure of 500 lb per square inch when running at full power. Negligible wear has taken place either in the pads or on the shaft collars.

In the tests Vacuum D.T.E. Medium Special lubricating oil was used and circulated at 2200 gallons per hour. The oil is fed through a duplex full-flow filter to the gas generator bearing at 20 lb per square inch and to the gearbox, governor and servo at 50 lb per square inch. There is a frame oil tank into which the

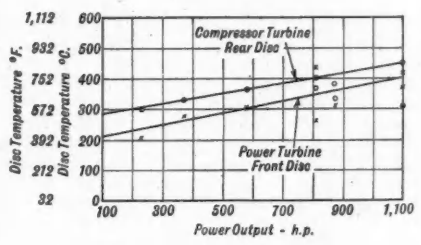


FIG. 7—*Turbine Disc Temperatures*

return lines from the bearings and gearbox drain direct. Samples of the lubricating oil have been examined at various stages of testing, and the broad conclusion is that little deterioration has taken place, and the oil should continue to give satisfactory service for a much longer period. Lubricating oils in steam turbines give service lives of up to ten years, provided that steps are taken to prevent the oil from being heated to a temperature exceeding about 170 deg. Fah (77 deg. Cent.) at any point in the circuit.

Fuel Pump.—Precision-made gear pumps have been used for the fuel supply, but difficulties have been experienced owing to seizures between the driving gear and its side plates. Such seizures have been traced to the entry of foreign matter which became trapped between the face of the gear and its side plate.

Ignition Equipment for Combustion Chambers.—The combustion chambers were originally fitted with torch igniters, in which a very small swirl-type atomiser was mounted adjacent to a low-energy spark gap. The spark gaps were fed from a 10,000V step-up transformer connected to the 230V mains. Ignition of the small atomisers was reliable and no difficulty was experienced in lighting the main atomisers as soon as the fuel was switched on, provided that both torch igniters had been previously lit up. Difficulties were experienced owing to the very small passages in the torch igniter atomisers becoming blocked by carbonised fuel. The igniter receives the full radiation from the flame in the primary combustion zone, causing carbonisation of the fuel in its swirl ports. This difficulty was overcome by use of a "high-energy" ignition system, consisting of a plug with very solid electrodes in each combustion chamber, the source of current being an 8 microfarad condenser charged by a transformer and rectifier to 3000V. This arrangement gives an intense spark at the plug in each combustion chamber once every two seconds, and, if the points are covered with carbon or

wetted with fuel, a more violent flash is produced than when they are clean and dry.

Governor.—For this gas turbine a special servo-assisted centrifugal governor was designed, having adjustments for the following variables: governed speed, permanent "droop," temporary "droop," and rate of synchronisation. The fundamental principles are similar to those embodied in the American Woodward and Marquette governors, though the mechanical design is completely different. The governor actuates an integral fuel valve through a servo system which is supplied from the turbine lubricating oil supply, the piston areas being so arranged that it is not possible to obtain full delivery from the atomisers if the oil pressure falls below a preset value. The permanent droop adjustment was set at the nominal position for synchronous governing, and under this condition the alternator r.p.m. fell by just under 15 as the load was increased from zero to full load, representing a permanent droop of 1 per cent. When the alternator was connected to the a.c. mains the adjustment was reset to give its maximum value of about 15 per cent permanent droop. With this setting the governor is very stable and the load carried can be adjusted within close limits. Synchronisation is easy, and by adjustment of the setting of the governor speeder spring it is possible to hold the synchroscope pointer absolutely steady; that is to say, there is no tendency for the governed speed of the turbine to fluctuate relative to the frequency of the mains.

Conclusions.

Throughout the testing of the Ruston 750kW gas turbine on only one occasion, during the eighteen months, has the set been shut down owing to a defect in the heat exchanger, and not once to a defect in the compressor or turbines. The main cause of lost running time has been the fuel atomisers, but the use of the Shell fuel-cooled atomisers completely cured this trouble. Other causes of lost running time have been the combustion system proper and the reduction gear.

As a result of this initial operating experience using distillate fuels, little trouble is to be expected from the two basically new elements in the gas turbine, namely, the compressor and the high-temperature turbines.

The large-scale utilisation of gas turbines in the future will depend upon their ability to run on residual oil fuels and upon solid fuels. In the author's opinion, a change-over to gas turbine power plant will take place in some sections of the industrial field during the next fifteen years. Initially, gas turbines will fulfil a need for peak-load power plants, for light portable power plants which require no water for their operation, and for traction applications in which the inherent torque conversion characteristic of a free-running power turbine is an important asset. As technique improves and additional experience is obtained on the problems of combustion and ash deposition, gas turbines will be found in increasing numbers in fields which have hitherto been the province of diesel engines or steam turbines, while we may ultimately expect gas turbine efficiencies to exceed those of present-day diesel engines when methods of blade cooling have been fully developed.

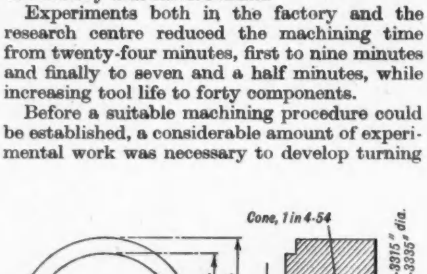
A Machining Problem Investigated at P.E.R.A. Laboratories

We have received from the Production Engineering Research Association particulars of increased production efficiency which followed a recent investigation into the machining of drawing dies. As a result of the findings of the investigation a reduction in the production time of dies from fifty-three to twenty-two minutes was effected.

The problem arose when the material used for the manufacture of the dies, similar to that shown in the drawing we reproduce, was changed in order to obtain a considerable increase in working life. The machining techniques for the original material were well established, but the new material, an alloy containing 1·88 per cent carbon, 0·76 per cent manganese, 0·38 per cent chromium, 0·31 per cent molybdenum, 0·30 per cent vanadium, and 6·73 per cent tungsten, proved so difficult to machine that the cutting tools needed regrinding after every five components or less. Although polished after hardening, the drawing dies were required to conform to high standards of accuracy and surface finish.

Experiments both in the factory and the research centre reduced the machining time from twenty-four minutes, first to nine minutes and finally to seven and a half minutes, while increasing tool life to forty components.

Before a suitable machining procedure could be established, a considerable amount of experimental work was necessary to develop turning



Drawing Die

tools, reamers and drills for machining the steel to the required accuracy and surface finish. The most difficult machining problem was presented by the formed bore of the die, and initial tests were conducted with cemented carbide inserted tooth reamers on a pillar drilling machine, a radial arm drilling machine and a centre lathe. Satisfactory formed bores were produced only after an extensive series of experiments with piloted and unpiloted cutters having positive and negative rakes, using different cutting fluids and varying combinations of feeds and speeds.

Three separate machines, namely, a capstan lathe, a contour lathe and a drilling machine, were used in the manufacture of each die in the factory. In order to facilitate production, reduce handling time to a minimum, and ensure the dimensional accuracy and concentricity of the bore with reference to the outside diameter, a procedure for machining the components completely on a capstan lathe was developed.

Initially, the capstan was tooled up with high-speed steel tools, except for cemented carbide roughing and finishing reamers and a bar turning tool but, after preliminary tests, a cemented carbide-tipped parting tool, carbide radiusing tool and a solid carbide fine-fluted parallel reamer were substituted for the existing high-speed steel tools. Experiments were continued until a formed bore could be produced with a surface finish of 8 to 10 micro-inches and concentric with the outside diameter within 0·0005in.

A great improvement was effected in the surface finish of the formed bore following the development of a satisfactory machining technique.

The operation sheet for the machining procedure developed for the new material at the research centre is reproduced above.

Machining Operation Sheet

Operation	Speed, r.p.m.		Feed, inches per rev.	Tool
1. Centre	506	Hand	—	Centre drill, H.S.S.
2. Drill parallel hole	210	Automatic	0·004	Twist Drill, "P" size, H.S.S.
3. Rough taper bore	90	Hand	—	Double-tooth cutter, cemented carbide
4. Finish taper bore	39	Hand	—	Double-tooth cutter, cemented carbide
5. Ream parallel hole	39	Automatic	0·004	Five-flute reamer, cemented carbide
6. Radius mouth	39	Hand	—	Spade type radius cutter, cemented carbide
7. Turn outside diameter	210	Automatic	0·005	Bar turning tool, cemented carbide
8. Turn shoulder	210	Hand	—	Bar turning tool, cemented carbide
9. Part-off	210	Hand	—	Parting-off tool, cemented carbide

Cutting fluid: 1 : 60 emulsion of soluble oil in water

Centenary of W. C. Holmes and Co.

Last year the well-known firm of gas plant manufacturers, W. C. Holmes and Co., of Huddersfield, completed its centenary, and to mark the occasion an interesting book has been published describing the origin, progress and activities of the company. The firm actually originated prior to 1800 and a foundry owned by Holmes and Price was in operation at Engine Bridge, Chapel Hill, Huddersfield, at the beginning of the last century. In 1809 it was in the hands of a John Holmes and later of the first William Cartwright Holmes, whose two sons, Joseph Francis and William Cartwright, succeeded to the business, and traded under the name of Holmes Brothers, "whitesmiths, bell-hangers and gas fitters." In 1850, three years after the works and premises were moved to Hillhouse, the firm was established at Whitestone Ironworks under its present name, W. C. Holmes and Co. William Cartwright Holmes was then only twenty-three years of age, but within a short time he started taking out patents concerning "Improvements in the Manufacture of Gas and Apparatus Employed Therein." The book reproduces a copy of an advertisement of the firm's which is typical of the industrial enterprise of those days. It reads: "Messrs. W. C. Holmes and Co. are prepared to assist in the establishment of gas works in any town or village which, after inspection, they know will return a fair dividend upon the outlay, by providing a portion of the required capital." During the ensuing twenty-five years more than 300 installations or extensions to existing gas works were carried out by the firm at home and abroad.

The company moved to a new works at Turnbridge in 1880, and shortly afterwards the manufacture of complete gas works was dropped for the specialised manufacture of cooling, purifying, storing and metering equipment for gas and, later, of plant for the recovery of by-products. In 1882 the manufacture of by-product recovery plant and refining plant for ammonia, tar and benzole was started and two years later a patent was obtained by the firm for a new washer scrubber employing West African piassava, a type of reed, which was treated to eliminate brittleness. The "Western" double-faced valve, which is still in great demand, was introduced in 1899. As a result of research carried out by the firm the process of gas dehydration, for the partial removal of water vapour from distributed gas, was patented in 1924. Manufacture of "Holmes-Connersville" station meters, exhausters, boosters and air blowers under licence was started in 1926, and the book gives an interesting account of the background and development of this type of equipment. The company constructed the first commercial plant for the improvement of ammonia still effluent in this country; it was installed at Manchester in 1929. In addition to the above-mentioned pieces of gas works plant and equipment, the book notes many others which have been introduced or developed by the company during its long history, and many of the notes are supplemented by brief, but interesting, details.

Some excellent photographs of the works and its products are reproduced in the book which will be read with interest by all who know the company or are interested in the history of gas works development in this country.

Laminated Torsion Bars

WE have recently received from Geo. Salter and Co., Ltd., West Bromwich, some details of the design and application of laminated torsion bars, the development of which has been in progress for some years. This firm, which has been concerned with the manufacture of springs and weighing machines since 1770, first became interested in laminated torsion bars some years before the last war. At that time, it was becoming increasingly evident that one of the next important contributions to improved passenger comfort in road vehicles would be that of suspending independently all wheels of the vehicle.

As a result of some early investigations carried out by the company into independent suspension systems, it appeared that due to the difficulties presented by the steering lay-out, a major problem was invariably that of housing helical coil springs of sufficient stability in the small spaces available. Considerations of these designs led the company's technical department to a number of conclusions which are dealt with in the following notes.

The normal helical coil spring, of round section material, which was at that time in general use in the industry, was exceedingly prodigal of space owing to the fact that it enclosed, of necessity, a relatively large core. At first sight it would appear that this waste could be minimised by coiling the spring on a smaller diameter, but, as it is essential that the spring shall "move" over a certain minimum distance, it is necessary that a ratio of "movement" to mean diameter be maintained, or a spring would become unstable and "buckle" when loaded. This led to the production and use of a car suspension spring that required 13 cubic inches of steel and yet occupied 124 cubic inches of space when fitted to the vehicle. Although helical springs of rectangular or square section can be made to occupy less space than those of round section, their advantage is more than outweighed by the fact that the surface of a round section may be ground and polished more economically than any other, and relatively higher stresses may be used, so that the space problem is hardly improved.

From space considerations the use of round section solid torsion bars has obvious advantages, since they are not "coiled." As, however, the modern car carries considerable spring weight, but must have, at the same time, a good spring movement, the section of a solid bar fixes itself within certain limits, which are set, on the one hand, by economic considerations, and, on the other, by the maximum stress developed on full deflection. If, therefore, the "rate" or load per unit of deflection is predetermined by the car designer, the operative length of the bar is also more or less fixed. Moreover, this length of bar is found to be quite considerable and special arrangements have to be made to ensure that nothing obstructs its location.

It should also be appreciated that the only way of fixing and adjusting a solid round bar is by means of splines, the production of which is an expensive item. Furthermore, the addition of fixing stresses to those imposed by the pure torque makes it necessary to "up-end" the solid bar so that there is a progressive thickening from the bar proper to the splined portion.

A laminated torsion bar, however, depends not only upon its gross cross-sectional area and its length for the load/deflection characteristics, but also upon the number of laminations and their individual shape. There are thus two further variables which may enable a reduction of the bar length to be attained without forfeiting flexibility. The fixing stress of a rectangular section is at maximum at the corners, while the torque stress is a maximum at the centre of the flat sides. Hence at no point are two maximum stresses compounded as they are in a round bar.

The firm therefore decided to embark on a programme of experimental work, to improve the suspension of a road vehicle. Work was commenced and, as a result of the considerable practical data obtained, a car was fitted with laminated torsion bar suspension and a comprehensive test given. Careful laboratory examination of the leaves at the end of this test failed to reveal flaws of any kind.

In 1939, however, further development of the laminated bar was postponed because of the company's wartime production commitments, and work was not resumed until the end of the war. Experiments were then carried out in order to establish a formula capable of rapid solution, whereby the design of a "set" for any given springing conditions would be no more difficult than, for instance, designing a "nest" of valve springs from the cam and follower profiles.

Various members of the motor trade were approached and a car having normal solid bar suspension was obtained and fitted on the off side with a laminated bar in place of one of the original solid units. A car of this type was chosen so that the modification could be effected without changing the lay-out of the steering and in order that a direct comparison could be made. This vehicle has now completed 12,000 miles in test and on the road, and the report following these trials is given below.

A LAMINATED TORSION BAR INSTALLED

The design of the spring used was as follows:

Seven leaves	1¼in × 0·176in
Active length...	14·1in
Total length	16·6in
Weight	7¼ lb

Tests

Immediately on assembly, the spring was given excessive shock loads, by driving the car across a rutted field and into and out of disused grass bunkers on a golf course, in order to "bed down" the leaves in their housing. It was expected that this would show itself in the form of a drop on the offside, but this did not prove to be the case. No "set" whatever was measurable at this stage.

The car was next run under all conditions for a distance of 4000 miles. It was then found that the distance between the edge of the wing and the ground had decreased by 0·187in, representing an infinitesimal angular set on the bar.

Arrangements were made with the Motor Industry Research Association to take the car to the testing ground at Nuneaton and subject it to as severe a test as possible. The part of the ground used consists of a triangular track having half-mile straights. It was suggested by M.I.R.A. staff that the Belgian Pavé section would give all the shocks required on a light car, but that if this was found to be insufficient there was a new "corrugated" section which was far more severe, and it was decided to use both sections alternately. After three runs the exhaust pipe-retaining bracket was broken; the internal fittings, sun vizor, &c., had become so loose as to warrant complete removal for safety, and the steering wheel base had shaken completely loose. At certain speeds on the "corrugated" section it had been possible to pick up a "period" which sprang the body sufficiently to allow the doors to open. In all, a total of thirty-two circuits was made, comprised of 16 miles pavé, 16 miles "corrugated," and approximately 30 miles "other surfaces." Speed of runs varied from 13 m.p.h. to approximately 50 m.p.h. on the rough sections. A final check revealed that the steering wheel had over 40 deg. free play, which was accounted for by the fact that retaining nuts on tapered pins in the steering linkage had worked loose. The "set" of the laminated bar had remained at about 0·187in, but that of the round bar was somewhat in excess of this figure.

It was noticed that the solid bar allowed definite "bottoming" far more frequently than the laminated, while "pitching" on the "corrugations" was definitely "corner to corner," indicating more damping on one side.

In addition to the experimental work, several successful suspension designs for individual racing and trials cars have been made, and at the moment during the "close" season quite a number of chassis are being modified to take this new suspension unit.

The makers consider that a suspension system incorporating this unit has several advantages. It is claimed that a bar composed of thin laminations has far greater flexibility than a solid bar, a property which makes it possible to envisage a torsion bar so short that it can be mounted across the open end of a conventional wishbone and anchored to the chassis in the middle. Thus, in addition to the safety factor provided by having a large number of laminæ, there are, in effect, two torsion bars in action instead of one. Such a mounting concentrates the stress in the chassis side members, in a relatively short length, which is more rigid and more easily braced than with the conventional long torsion bar; the buttressing of the chassis at this point is already largely provided by the front cross member and engine mounting. If one chassis is fitted with two types of body work of differing weight and/or capacity, the springing characteristics can be varied to suit, by means of a simple fitting developed by the makers. The damping characteristics may be reduced if required by interleaf polishing, &c., and it is claimed that a laminated bar has about 300 per cent of the damping capacity of the normal torsion bar or coil spring. The rectangular section of the pack makes anchorage a comparatively straightforward and inexpensive matter, and the makers say that the overall

simplicity of the unit is expected to effect a considerable saving in price over either coil springs or conventional torsion bars.

A number of other applications of the laminated torsion bar have been developed which have proved satisfactory in widely different fields. For heavy duties a laminated torsion bar has been manufactured which is being used as the measuring agent in an undercarriage testing rig with a maximum capacity of 15,000 ft-lb. It can also be envisaged that in a heavy armoured vehicle, where flexibility and not weight is the prime consideration, by increasing the number of leaves and, at the same time, reducing their individual size, the angular movement of a trailing link can be considerably enlarged. Considering the hypothetical case of a solid torsion bar of 50in active length, 1·5in diameter and with a trailing link of 20in length, a load of 1100 lb would be supported at 20in radius and permitting a further wheel movement of 7¾in at a maximum shear stress of 100,000 lb per square inch. Since these bars are normally taken the full width of the vehicle, the length and, hence, the thickness are automatically fixed by the stress limitations.

Using a laminated torsion bar, and regarding the length and stress as the only non-variables, the makers claim that the use, say, of eight leaves 3in by ¾in, would still enable a load of 1100 lb at 20in radius as before, but would allow a further permissible movement of 14¼in.

Laminated torsion bars have been adopted in certain other mechanisms in order that the action is not forced to depend upon a single piece of spring wire, but on a set of leaves, whereby the breakage of one leaf would be indicated at once by some sluggishness in action and not by complete failure.

Electricity Supply Developments in South Africa

THE Electricity Supply Commission of South Africa is to spend £54,000,000 on its present expansion programme, which will include the building of seven new power stations and extensions to seven existing stations. The Hex River station, the first new plant due for completion under the present expansion programme, is expected to be in full operation early in 1952, and is one of the nine out of the fourteen schemes in hand which are being designed and built solely by the Commission. The remaining five stations are being designed by Messrs. Merz and McLellan.

Taaibos

One of the more interesting developments is the Taaibos plant, which will supplement the station at Vierfontein, in the Free State, in its primary task of supplying power to the new goldfields and its secondary role of supplying the grid serving the highly industrialised Witwatersrand area. Taaibos is also situated in the Free State, some 22 miles from Vereeniging. Initially it will have two pulverised-fuel-fired, two-drum boilers, with an evaporative capacity of 580,000 lb per hour, the largest equipment yet to be installed in South Africa. Each boiler will be fully suspended from the boiler house frame. The boilers, with their turbines, are expected to be in commission in March, 1954. They will have 630 lb per square inch pressure at the superheater stop valve, 850 deg. Fah. final steam temperature, and 338 deg. Fah. feed water inlet temperature. The boilers will be fired by four "E" type pulverising mills. The drums are to be of fusion-welded construction. Taaibos will use the unit system without steam receivers, but with connecting pipework for the purpose of supplying steam from boilers to adjacent turbo-generators, if and when necessary. Each boiler will have two forced draught and two induced draught fans, and four primary air fans, with four seal-air fans. The induced draught fans only are driven through hydraulic couplings. Each of the electrically driven boiler feed pumps will deliver 700,000 lb per hour and steam-driven pumps delivering 350,000 lb per hour will also be installed.

The fuel will have an average calorific value of 9200 B.Th.U. per pound as fired, with an ash content of 22 per cent and a volatile content also of 22 per cent. Cellular grit collectors will be installed, with provision for electrostatic precipitators at a later date should they be found necessary. The ash-handling plant will be the "hydrojet" system, pumping to an ash dam, with no recirculation of water.

Taaibos is being laid out with a single line of boiler units and one machine to each boiler. After the first two boilers and sets are in operation, it is expected that others will be installed at six-monthly intervals until there are five boilers in commission.

The turbines installed will be three-cylinder reaction machines of 60MW maximum and most economical rating—the largest machines ever to be imported into the country. Generation will be at 11kV at 50 c/s with a normal speed of 3000 r.p.m., a steam pressure of 600 lb per square inch (gauge) and 825 deg. Fah. temperature. There will be two evaporators per machine, each of 12,000 lb per hour capacity when supplied with bled steam from the turbines. Heating will be four-stage, raising the condensate temperature from about 40 deg. to 180 deg. Cent.

Each generator is connected by busbars (totally enclosed in metal ducting) to a 70MVA, 11/132kV transformer with "ON/OB" cooling. The generator transformers will be connected through 132kV circuit breakers to the station busbars in the outdoor substation. The station will be connected with the Commission's existing Vaal station through 60MVA, 132/88kV "ON/OB" transformers at Taaibos. These transformers are to be three-winding units, the tertiary winding at a nominal voltage of 3·3kV supplying station auxiliaries. Supplies to unit auxiliaries of the turbine and its boiler will be derived normally from a unit auxiliary transformer connected solidly to the generator.

Hex River

The Hex River station in the Cape Province will initially comprise four boilers, each with an evaporative capacity of 200,000 lb per hour, with three 11kV turbo-generator sets designed for a continuous maximum rating of 20MW, steam conditions of 600 lb per square inch, and a temperature of 800 deg. Fah. at the stop valve.

The electrical lay-out is unusual in that the generators tie-in to the coupling between the 66kV and 11kV busbars, thus giving power through step-up transformers to the main 66kV switchgear, which will supply the railway electrification and towns along the transmission lines which tie-in with the Cape power stations, and also through reactors to the 11kV switchgear, which will supply Worcester Town and the local farms. Supply to auxiliaries will be from station transformers connected to the 11kV switchgear. The station will have the first spreader-stoker system to be operated at a power station in South Africa. This system allows for very simple ash-handling arrangements. The stokers will discharge into lorries and the grits from the grit arrestors will be carried by conveyor and elevator to an ash bin which will also discharge to lorries.

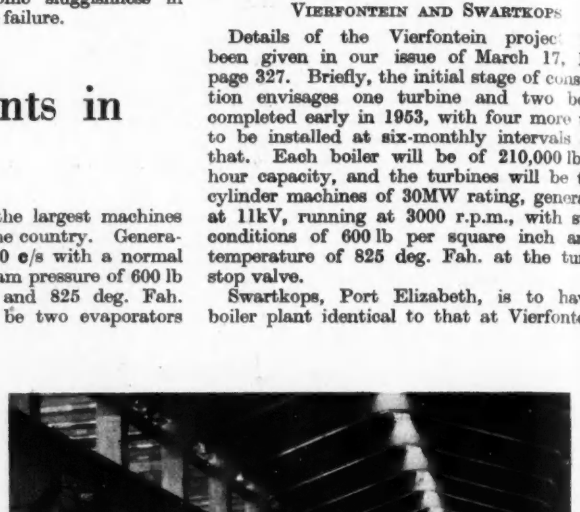
Hex River will be unusual in another respect—the turbine house structure is a portal arch construction of box-frame girders, thus eliminating cross bracing. Again, this is the first time that this kind of construction has been used in a power station in South Africa. The turbine house structure, with the steelwork of the foundation block of one of the turbo-alternator sets in the foreground, is shown in the accompanying illustration.

Vierfontein and Swartkops

Details of the Vierfontein project have been given in our issue of March 17, 1950, page 327. Briefly, the initial stage of construction envisages one turbine and two boilers completed early in 1953, with four more units to be installed at six-monthly intervals after that. Each boiler will be of 210,000 lb per hour capacity, and the turbines will be twin-cylinder machines of 30MW rating, generating at 11kV, running at 3000 r.p.m., with steam conditions of 600 lb per square inch and a temperature of 825 deg. Fah. at the turbine stop valve.

Swartkops, Port Elizabeth, is to have a boiler plant identical to that at Vierfontein—tri-drum equipments, fired by twin "L" type chain grate stokers. Each of the two boilers will have an evaporative capacity of 210,000 lb per hour. The steam and water drums are to be of solid forged construction, and there will be a water-cooled furnace with Murray fin tubes. The furnace heat release will be about 30,000 B.Th.U. per cubic foot of furnace volume.

Each of the two turbo-generators for Swartkops will be a two-cylinder reaction unit of 16MW most economical rating and 20MW continuous maximum rating, the speed being 3000 r.p.m. The steam pressure will be 600 lb per square inch (gauge) at stop valve, and the temperature 825 deg. Fah. A total of 17,500 square feet of cooling surface is presented by each of the two-pass condensers. The circulating water will be obtained from the sea through a battery of pumps situated in a pump house at the end of an inlet culvert and delivering to a 48in diameter concrete main running beside the pump basement. The two ventilating



TURBINE HOUSE, HEX RIVER POWER STATION

fans for the turbine plant will be centrifugal units, each driven by 76 h.p., 380V motors, and delivering 36,000 cubic feet per minute, while the unit evaporator will have a capacity of 7000 lb per hour when supplied with bled steam from the turbine.

Generation is at 11kV. The generator transformers step up this output to 22kV for supplying Port Elizabeth through 22kV oil circuit breakers of 750MVA breaking capacity. Supply to auxiliaries is normally from unit auxiliary transformers connected directly to the generators.

Umgeni, Salt River and East London

The other three new stations, at Umgeni (Natal), Salt River (Cape) and East London are being constructed for the Electricity Supply Commission by Messrs. Merz and McLellan, in conjunction with the Commission's engineers. The new Umgeni plant is due to be in commission in 1953 with four boiler units, the last pair of which are expected to be ready a few months after the first two are installed. The boilers will have an evaporative capacity of 180,000 lb per hour each, pressure of 625 lb per square inch, a maximum temperature of 865 deg. Fah., and a feed temperature of 340 deg. Fah. There will be one twin "L" stoker per boiler. The first and second turbines will each be of 30MW capacity, laid out in line. The coal will vary from 11,500 to 13,000 B.Th.U. per pound gross, and will have a volatile content of 17 to 30 per cent and an ash content of 15 to 20 per cent. A paddle ash extractor system will be used for ash handling. There will be three motor-driven boiler feed pumps, of 360,000 lb per hour capacity, and one steam-driven feed pump, of 370,000 lb per hour capacity.

The new station at Salt River, Cape Province, to supplement the existing Escom plant there, is due to be operating in 1954, and will comprise two 30MW turbines and four water-tube boilers, each producing 260,000 lb per hour steam at 635 lb per square inch pressure, with a maximum temperature of 915 deg. Fah. and a feed temperature of 340 deg. Fah. with chain grate stokers.

The last of the new power stations at present envisaged by Escom is that at East London, also supplementing an existing plant. The project involves unusual engineering difficulty in that, due to the height of the land above the sea, it is almost impossible to find a suitable site in East London where river or sea water for cooling is economically available.

It was finally decided to excavate a 25,000 square foot site out of the cliff face in the harbour area. The foundations for the new plant are therefore all in rock, and blasting will be necessary for the culverts and, indeed, everything below ground level. In addition, special protective measures will have to be taken to by-pass storm water from this site, as hydraulic pressure built up behind the excavated rock face has already been responsible for rock movement. This new East London station will be in commission in 1954–55 and will comprise seven 170,000 lb per hour stoker-fired water-tube boilers.

The completed power station will include six turbo-alternators of 15MW continuous maximum rating. Initially two machines will be installed. The turbines are designed for steam conditions of 400 lb per square inch (gauge), 800 deg. Fah. and are of single-cylinder construction. Special arrangements are to be made at this power station so that it may operate either on suitably treated potable water from the municipality, or on water taken directly from Buffalo Harbour.

Vaal Extensions

The extensions to the Vaal station are of greater magnitude than the total scope of many of the new plants just reviewed, as eight new boilers and four new turbines are to be installed, bringing the station's complement up to eighteen boilers and nine turbo-generators.

Each boiler will have a maximum economic rating of 190,000 lb of steam per hour, 360 lb per square inch pressure at superheater stop valve, 833 deg. Fah. final steam temperature, and 248 deg. Fah. feed water inlet temperature.

The boiler feed pumps to be installed will be electrically driven, delivering 450,000 lb per hour of water. No steam pumps are included in the present extensions as two steam-driven emergency pumps are already installed. There will be high-pressure pipework extensions to the present steam range and the steam receiver installation will contain special precautions against the effect of corrosion fatigue.

The four tandem-cylinder impulse turbines to be added to the Vaal station will have a maximum and economic rating of 33MW at 3000 r.p.m. Generation will be at 10·5kV. The station is to have two-pass surface condensers with a cooling surface of 30,000 square feet. There will be three heater units, two low-pressure and one high-pressure, raising condensate temperature from 40 deg. to 119 deg. Cent.

Electrical equipment includes four main 45MVA, 10·5/88kV step-up transformers. The 400A, 88kV outdoor circuit breakers will have a rated breaking capacity of 1500MVA.

A house set for supplying the station auxiliaries is also being installed at Vaal, with a single-cylinder radial-flow turbine of 7MW maximum and economic rating, with steam pressure of 350 lb per square inch at the stop valve, and temperature of 800 deg. Fah.

Congella

One of the earliest extensions to existing stations to come into operation will be that at No. 2 station, Congella (Natal), where three boilers and one turbine are to be installed as the final stage in the installation of three 40MW, turbo-generators, and eight 200,000 lb per hour boilers in that station. The boiler pressure is 625 lb per square inch and the steam temperature 825 deg. Fah.

Type "E" mills will feed the pulverised fuel boilers, which will be provided with self-draining superheaters and flash-welded economisers. Steam temperature is controlled by attemperators and by adjustable gas by-passes to superheater sections. The air heaters will be regenerative, with two forced draught, two induced draught and two primary air fans. The forced draught and induced draught fans will be vane controlled.

The main feed pumps will be electrically driven and have a capacity of 400,000 lb per hour. A pneumatic system will be used for fly-ash collection and the ash-handling plant will employ the "hydro-jet" system, pumping to a settling tank.

Colenso and Kimberley

Colenso station, which is also in Natal, is due for similar extensions. Three new boilers and one turbine—the second step in the completion of the No. 2 station—are planned to be in operation in 1953. The boilers will be of 180,000 lb per hour capacity, with 300 lb per square inch pressure and 775 deg. Fah. temperature. These, with the rest of the equipment, will duplicate plant already supplied. The turbo-generator will have a rating of 25MW, generating at 13·2kV and solidly connected to a transformer, which will be a 28MVA, 13·2/88kV, "ON" three-phase unit. The 88kV circuit breaker will have a 1500MVA rupturing capacity.

The Kimberley extensions are interesting in that, with the proposed enlargements, the cooling water supplied by the adjacent vlei (pond) is insufficient, and the amount of water for making up the vlei against evaporation would be such as to be uneconomical. Therefore, it has been decided to change the water-cooling system entirely and to cool all circulating water through a battery of forced draught cooling towers, which will be the biggest installation of their kind yet used by a power station in South Africa. The extensions comprise two 5·5MW sets transferred from Congella power station, and two 75,000 lb per hour continuous maximum rating stoker-fired, water-tube boiler units.

Other Extensions

The remaining work Messrs. Merz and McLellan have in hand for the Commission is the extension to East London's West Bank power station No. 1. This comprises two 55,000 lb per hour C.M.R. stoker-fired, water-tube boilers, and one 7·5MW turbo-alternator. Commissioning is due in April–May this year. There will be two 11/6·6kV transformers and one 500kVA, 11/0·4kV station transformer.

Extensions to the existing Witbank station will comprise two boilers fired by chain grate stokers, and one single-cylinder reaction turbine of 20MW maximum and economical rating at 6kV, 3000 r.p.m. The boilers will have an evaporative capacity of 80,000 lb per hour at 225 lb per square inch pressure at superheater stop valve, 715 deg. Fah. steam temperature and 240 deg. Fah. feed water temperature.

The turbine will have a steam pressure of 208 lb per square inch (gauge) at the stop valve, with a steam temperature of 662 deg. Fah.

The last of the seven plants now being extended is the Vereeniging station, where one boiler is to be installed without addition to the generating capacity. The boiler will be fired by a twin chain grate stoker, the evaporative capacity being 160,000 lb to 180,000 lb of steam per hour at 230 lb per square inch of pressure, 752 deg. Fah. steam temperature, and 212 deg. Fah. feed water inlet temperature. The superheater will be of multi-loop design, and there will be a return bend economiser and a tubular air heater. The furnace will have a heat release of 29,000 B.Th.U. per cubic foot per hour.

Transmission

All this development, covering the four provinces of the Union, has naturally brought with it expansion on the transmission side, and one of the longest new lines to be erected will be from Bellville (Cape) to Worcester, and then beyond to Hugo, near Touws River—a distance of about 120 miles. It will be a 66kV transmission line, of 0·1 and 0·15 square inch copper conductor. As far as Worcester the towers of this line will be reinforced concrete structures.

Each tower will comprise two spun reinforced concrete poles with precast reinforced concrete cross arms. The strain towers will also be of reinforced concrete, built on the site, but using precast cross arms.

In the Free State–Witwatersrand development, there is to be a new 132kV line from Vaal power station to Vierfontein, which will be a 0·2 square inch copper equivalent steel-cored aluminium line. In addition, there will be initially two 132kV, 0·25 square inch copper equivalent steel-cored aluminium lines from Vierfontein power station to the goldfields. The distance from Vaal to Vierfontein is 80 miles, and from Vierfontein to the Free State goldfields 60 miles. All three lines are to have H-pole suspension structures, with the poles of welded hexagonal design.

An interesting line will be erected from Bethal to Standerton—a distance of 45 miles—in which wood poles will be used on an 88kV line. Advantage has been taken of the impulse strength of the wooden cross arms so that the impulse strength of the line will be of the same order as a 132kV line with steel structures. Here the wooden structures will be H-poles carrying 0·125 square inch copper conductors.

Rust Prevention.—A new method of packaging metal components, using a special rust-preventive paper, has been developed by Shell Petroleum Company, Ltd. This "V.P.I." (or vapour phase inhibitor) paper is coated with a chemical which, by slowly vaporising, forms a very thin film on metal surfaces and thereby protects them from corrosion. Although moisture and oxygen are necessary for rusting to take place, "V.P.I." does not react with or remove either of them, but instead operates successfully in their presence by actually inhibiting their corrosive actions. The makers state that even when there is a film of moisture present—as may often occur in a very humid atmosphere—"V.P.I." still protects by dissolving in the condensed water and thereby making it non-corrosive. So long as the paper is not more than 1ft from any part of the surface of the metal being packed, it is claimed to give complete protection for anything up to five years, depending on the type of wrapping used.

THE ENGINEER

Vol. CXCI MARCH 16, 1951 No. 4964

Contents

	PAGE
LEADING ARTICLES—	
Improvements in Factories	352
Problems in Air Transport	352
SPECIAL ARTICLES—	
Education for Industry	356
High Temperature Steels and Alloys for Gas Turbines Iron and Steel Institute. No. II	342
Industrial Economics of Metallurgy	343
Institution of Naval Architects. No. I	357
Manufacture of Deep Drawing Steel. No. II (Illus.)	338
Rotary Chart Translator. (Illus.)	340
Aluminium Structural Panel. (Illus.)	359
Annual Report on Road Research	357
Atomic Energy Research Establishment	358
Cast Milling Cutters	358
Centenary of W. C. Holmes and Co.	348
Conference on Diesel Locomotive Productivity Report	355
Electricity Supply Developments in South Africa (Illus.)	350
Further Mechanical Aids for the Foundry. (Illus.)	360
Improvements at Euston Station	359
Laminated Torsion Bars. (Illus.)	349
Launch of "Ucayali"	355
Machining Problem Investigated at P.E.R.A. Laboratories. (Illus.)	348
Operating Experience with a 750kW Gas Turbine. (Illus.)	345
Small Layer Thickness Meter. (Illus.)	359
Virtues of Standardisation	363
LETTERS TO THE EDITOR—	
Reactive Force in a Turbine Nozzle	355
Early Electrical Apparatus	355
Gas Council Report	355
LITERATURE	354
OBITUARY—	
H. A. Humphrey	353
F. C. Knowles	354
A SEVEN-DAY JOURNAL	337
Factory Inspector's Report	
Industrialists to Assist in the Rearmament Programme	
Institute of Marine Engineers Annual Dinner	
Report on Transport Helicopters	
Retirement of Mr. B. C. Curling	
NEWS AND NOTES—	
Books of Reference	364
British Patent Specifications. (Illus.)	367
British Standards Institution	360
Contracts	366
Forthcoming Engagements	368
French Engineering News	364
Industrial and Labour Notes	365
Launches and Trial Trips	366
Notes and Memoranda	366
Personal and Business	366

IMPROVEMENTS IN FACTORIES

SLUM clearance used, before the war, to be an item frequently to be found on the agenda of local authority meetings. We hear less about it now. For the housing shortage is so acute that emphasis tends nowadays to be placed rather upon the erection of new buildings than upon the demolition of old ones. But just as there can be "slums" amongst houses they can exist, too, in industrial premises. Indeed, restriction upon new building and shortage of factory space tends sharply towards the creation of new industrial slums. In the Annual Report for 1949 of the Chief Inspector of Factories, just issued, publication having been delayed by the printing dispute last autumn, an instance is quoted of a building originally constructed as a church presbytery being converted not into one, but into a number of small factories leased to separate tenants. These premises were, in fact, so unsatisfactory that an appeal to the Courts was made and orders were issued prohibiting their use for the purpose. But in default of better accommodation, small-scale employers—and sometimes large-scale ones, too—are often forced to buy, lease or rent premises that are not really suitable for industrial operations. In these circumstances it is satisfactory to learn that in "the elimination of what have been termed the old and slum-type factories . . . the position throughout the country is very little different from that indicated last year." It might well have been expected to be growing worse.

The improvement of working conditions in factories has, of course, gone on ever since the modern factory system was created by the Industrial Revolution; and, at least since the days of Lord Shaftesbury, it has increasingly become the concern of Governments to lay down certain maximum hours of labour and certain minimum standards of sanitation, hygiene and safety in factories. But, if, when they first began to visit factories, H.M. Inspectors, whose job it is to see that regulations are abided by, were not always welcomed, the situation has long since changed. To-day the majority of firms up and down this country value the visits and the advice of the inspectors, even if sometimes they remain critical of the measures that these men persuade rather than compel them to carry out. A great and growing number find it an advantage to consult an organisation with such wide experience when laying down new works or starting new processes. Many firms, indeed, are leading the way in providing working conditions that do not merely comply strictly with the letter of the law but generously interpret its spirit, a fact acknowledged in the Report. Nor are such progressive firms only to be found amongst the large and wealthy. Many a small firm on a trading estate or elsewhere, often despite the defects of its premises, takes as much pride in its care for the health, happiness and safety of its workpeople as in the high quality of its products. Since the war, indeed—were it not for the counter effect of the scarcity of suitable buildings—we believe it would be found that the trend towards improvement has been much accelerated. For scarcity of labour is unquestionably leading managements to study more closely the amenities in their factories, since, other things being equal, that factory which has the better conditions will attract more labour and a higher degree of skill. Lighting, heating and ventilation have all been the subjects of quite recent improvements and it has been found that profit goes hand in hand with humanity. For improved working conditions have led to increased output. Notably the Report remarks: "In most parts of the country the idea of using colour for factory decoration seems to have become firmly established." Concurrently with such repainting there is noted a rising standard of cleanliness, for managements and men have realised that "it affects health and efficiency and to achieve it careful planning and proper organisation are essential." In this country, since the war, there has been a very noticeable development of chemical processes. Such processes are found in factories making such things as industrial solvents and new plastics; and in the paint industry there is a growing preference for the use of synthetic resin plastics. The Report also refers to the growing usage, for instance, of ultrasonics, electronics and radiology. "All these new developments have brought with them special problems of health and safety." It is encouraging to learn that the Inspector's organisation has been freely consulted in both the design and operational stages of setting many such new plants to work.

In no other shop, probably, has the improvement of amenities been so remarkable since the war as in the foundry. Those advances owe something, at least, to the actions of inspectors in pressing repeatedly for improvements. They have, too, been stimulated by scarcity of labour and the difficulty of attracting apprentices to the trade. If, indeed, the majority of foundries to-day still have dust-laden atmospheres and little provision for the removal of fumes, there are a number of examples to show what can be done towards improvement. In mass production foundries, as was shown by a paper by Mr. Beech, discussed by the Institution of Mechanical Engineers last Friday and abstracted in this issue, mechanisation makes possible the eradication of dirt, dust and fumes and the creation of conditions as pleasant as those ruling elsewhere in a works. But even in the jobbing foundry, where mechanisation cannot be so complete, it is still possible, Mr. Beech shows, "to cut out the donkey work by the use of electric horsepower and at the same time leave the skill, such as pattern drawing, gating, patching, &c., to the individual moulder," and simultaneously make his surroundings more congenial. For even the dust and fumes that have seemed for so long the inevitable accompaniment of knocking-out and fettling can be eliminated by the use of extractors and of hydro-blast cleaners and similar equipment. One final point. The work of the Inspectorate always has been and always will be particularly associated with the prevention of accidents. In fact, some three-quarters of the Report is taken up by the enumeration and study of accidents that occurred in industry during the year. The number of accidents notified shows a welcome reduction upon that of the previous year, continuing a downward trend since 1941, both in the total number and in the accident rate per thousand employees. The Report remarks: "A substantial reduction in the total of industrial accidents might well be effected if everyone thought a little more of himself first. This may sound a selfish outlook, but if a worker is personally determined not to be hurt, or a manager safeguards his position by having no trouble over accidents in his department, although each may be considering the effect on himself personally, the final result will probably be fewer accidents."

PROBLEMS IN AIR TRANSPORT

IN his Commonwealth and Empire lecture last autumn before the Royal Aeronautical Society, Sir George Cribbett, of the Ministry of Civil Aviation, urged that any trend there may be towards closer international co-opera-

tion in other fields should find its reflection in air transport, though he frankly admitted that national sovereignty and prestige must be expected to exert their influence towards independence in action. It is to be hoped, however, that any such independence in principle would be tempered by a move towards rationalisation in practice. It is natural that airlines charged with the hard task of justifying their financial results should seek some measure of protection in the home market, as well as a fair opportunity overseas, although realising that governments with their wide responsibilities for promoting economic transportation must be on guard against any action that might give encouragement to the growth of inefficient practices. Prestige considerations are no doubt largely responsible for the determination by almost all sovereign states to participate in international air transport, even in face of the probable consequence that there may arise such a provision of load capacity as to be beyond the traffic demand corresponding to world economic conditions and the current level of fares. Fortunately, there is in being an International Air Traffic Association, with its headquarters at Montreal, which now represents more than seventy airlines drawn from over forty countries, and it can and does advise on the vexed question of rate fixing. Sir George summarises the degree of success met with in this endeavour by his estimate that the post-war increases in fares in this country at the end of 1949 did not exceed 35 per cent, compared with a wholesale commodity advance in price of about 125 per cent, and lying well within the increase in British railway fares of some 55 per cent.

It is, of course, no easy matter to compare fairly the economic performance of air and land transport. Railways provide their own runways, but in the case of road and air transport the runways are provided at Government cost. Signalling facilities in transit are an internal matter on the railways, but are largely undertaken gratuitously by the State in the case of airways. Large annual subsidies are paid to the airline operators, as in effect they now are to British Railways, but, as Sir George points out, the airline subsidy payments have been falling steadily in proportion to output. Thus, the subsidy per load-ton-mile flown is given as 84d. twenty years ago, 26d. ten years ago, and has now fallen to 20d.—and this despite the decreased value of each of those pence. Indeed, the lecturer was bold enough to forecast that the increased efficiency of coming aircraft types might well lead to a Transatlantic operating cost (apart from overheads) of no more than 1·75d. per seat-mile; granted favourable conditions and a steady growth of airmindedness it might, even lead to the extinction of the need for State subsidy, and that within but a few years. In so far as this happy prospect depends on the continued popularity of air travel, there seems little to fear. During the past twelve months the number of passengers carried by our largest airways corporation has risen by 20 per cent, whilst over the past two years the passenger-mile figure has increased by no less than 50 per cent. It has been suggested by *The Economist* that a fitting yardstick for such comparisons would be the ratio of "capacity-ton-miles flown per employee," and by way of illustration that journal cited the B.O.A.C. achievement, some three years since, at the figure of about 2500. On that basis it was encouraging that by the year 1949 the ratio had risen to at least 3500 (also, as it happens, the figure for the B.E.A. Corporation), even taking the basis as ton-miles not of capacity, but of actual earning.

The coming of the "Comet" airliner is attracting great public attention and on its performance much will no doubt depend. It is interesting that five years ago, when addressing the Royal Society of Arts, Major Halford, of the de Havilland Engine Company, predicted that within ten years there should be airliners capable of flying at a cruising speed as high as 615 m.p.h. at 40,000ft. Half of that decade has passed, and it seems that this prophecy (unlike so many others in this baffling field) may well be fulfilled by the time the decade is completed. Higher speeds are liable, however, to lead to an increase in the accident ratio and so hinder the popularity of air travel. But, as has lately been pointed out in these pages, much can be done to improve safety by greater attention to the design and construction of the passenger accommodation on airliners. So far there may have been what may be called "sales resistance" to the drastic proposal that airliners should in future be fitted with rearward facing seats, as affording far better security for passengers in the event of heavy landings; but the experience in a crash landing last December of a Transport Command "Hastings," which was so fitted, without there being a single casualty among the passengers whilst the crew of five, facing forward, were all killed, must have gone far to convince doubters. It may well be that action in this matter by the licensing authorities would now be generally welcomed, and we are glad to see that this, among other safety measures, will be one of the subjects debated at the meeting of the International Civil Aviation Organisation (I.C.A.O.) at Montreal during this month.

Obituary

H. A. HUMPHREY

We regret to have to record the death of Mr. Herbert Alfred Humphrey, which occurred in Hermanus, C.P., South Africa, on Friday last, March 9th. Mr. Humphrey had reached the advanced age of eighty-two and retired from active work some years ago; but there are many engineers who remember his many achievements, and, in particular, his invention and development of the Humphrey gas pump.

Herbert Alfred Humphrey was born in London on December 2, 1868, and was educated at the Finsbury Technical College and at the Central Institution of the City and Guilds of London, where he studied under the late Professor W. Cawthorne Unwin. His first appointment in the engineering industry was in 1888 as a manager in the ironworks of Heenan and Froude, Ltd., at Manchester. In the following year he was transferred to that company's engineering works in Birmingham, where he remained until 1891. Humphrey then took up an appointment as departmental manager and engineer in the chemical works of Brunner Mond and Co., Ltd., Northwich, and there began an association with that firm and its associates which continued for many years, as, for a long period of his professional career, he acted as consulting engineer to Imperial Chemical Industries, Ltd., and its predecessors. Humphrey's work at Northwich was concerned, amongst other things, with the development and application of the Mond gas producer plant. Much of that work is described in a paper which he presented in 1897 to the Institution of Civil Engineers, and for which he was awarded a Telford Gold Medal and Premium.

In 1901 Mr. Humphrey returned to London to start up a consulting practice in Westminster. A great deal of his work in the years prior to the first World War was connected with the generation and distribution of producer gas. It was during that period that his ideas for the Humphrey internal combustion pump were being formulated. The initial research and experimental work occupied much of his time and thought, but his aim, as he recorded in a paper to the Institution of Mechanical Engineers in 1909, was to produce a pump of great simplicity and strength of construction in which the explosive force was exerted directly upon the water, and in which no rotating flywheel, solid piston, connecting-rod, crank, bearings, or glands of any sort were required. The first large installation of Humphrey pumps was decided upon in November, 1910, by the Metropolitan Water Board, which was then planning the construction of its new reservoir at Chingford. Although the Humphrey pump was at that time in its infancy, Mr. W. B. Bryan, the Board's chief engineer, was convinced that it offered the best solution of the problems arising over the Chingford works. The only example of the invention then in existence was at Dudley Port in Staffordshire. That pump had a cylinder not more than 30in in diameter and developed about 35 pump horsepower, but four of the five pumps ordered for the Chingford waterworks each had combustion chambers measuring 7ft in diameter, and each developed about 250 h.p. A full description of these pumps was printed in The Engineer of March 14, 1913, and it is worthy of note that they are still operating occasionally, nearly forty years after their installation. After the first World War the manufacture of the Humphrey pump was taken up for a time by William Beardmore and Co., Ltd., among the contracts received being one for an installation in Australia.

Mr. Humphrey gave outstanding service to the nation during the first World War. His ability and experience as a chemical engineer led to his taking a prominent part, as Technical Adviser to the Department of Explosives Supply, in the efforts that were required to maintain the production of high explosives. He was mainly responsible for the construction and equipment of factories in this country for making ammonium nitrate, and when, after the war, Brunner Mond and Co., Ltd., decided to go ahead with the scheme at Billingham for producing synthetic ammonia by the Haber process, Humphrey was called in as consulting engineer for the necessary works. Later on, in 1928, he acted as consulting engineer for Imperial Chemical Industries, Ltd., for the steam and electric power plant erected at Billingham.

Informative accounts of much of the work accomplished by Mr. Humphrey during his distinguished professional career were given in the papers which he presented from time to time to the various institutions to which he belonged. He was a member of the

Institution of Civil Engineers—by which he was awarded the Telford, Willans and Watt Gold Medals—a member of the Institution of Mechanical Engineers, and of the Institution of Electrical Engineers. He was also a Fellow of the City and Guilds Institute and a Fellow of the Institute of Fuel. To the latter he delivered, in October, 1939, the Melchett Lecture, which dealt with the supply of explosives during the first World War, and also with the early history of Billingham. In the same year, Mr. Humphrey was elected a Vice-President of the Institute of Fuel, and received the Melchett Medal in recognition of his outstanding research and other professional work.

F. C. KNOWLES

We regret to learn that Mr. F. C. Knowles died, in his seventieth year, on Sunday, March 4th, after a long illness, at his home in Chidham, Sussex. He was a well-known figure in the instrument industry and almost the whole of his working life was devoted to the advancement of the science and practice of measurement.

Frank Clements Knowles was born in Stoke and received his early education privately. Later he won a scholarship at the East London College (now Queen Mary College), where he took courses in mechanical and electrical engineering, after which he specialised in electrical testing at University College, London. His early industrial experience was gained at W. T. Henley's Telegraph Works, Ltd., North Woolwich, and subsequently with Messrs. Foxcroft and Duncan Dalston, successors to Paterson and Cooper, Ltd.

In 1900 Mr. Knowles joined Evershed and Vignoles, and was, for many years, concerned with the development, manufacture and testing of the company's products. He became technical assistant to the managing director, the late Mr. E. B. Vignoles, in 1911, and was made sales manager in 1923. When he retired from this position twenty-six years later, he was appointed a director of the company.

Mr. Knowles was a member of the Institution of Electrical Engineers and a past-chairman of its Measurements Section. He was also a member of the Association of Mining Electrical and Mechanical Engineers, and served as President of its London Branch in 1934–35. Among the technical societies that claimed his close interest was the Society of Instrument Technology; he was a founder member and served on its first council.

Literature

Legal Phases of Engineering: Contracts and Specifications. By Ivan C. Crawford, C.E., Sc.D. London: Macmillan and Co. Ltd., St. Martin's Street, W.C.2. Price 28s. 6d.

In this book, which is written for the student, the author is concerned to make the young engineer acquainted with the legal relations peculiar to his profession. Such knowledge, he affirms, will "help him prevent legal tangles and assist the attorney in case they arise." A second objective is to bring to the student an understanding of the process in arriving at a final decision. A third objective is to bring about an appreciation of clear precise contracts and specifications.

The syllabus of the work is comprehensive indeed. In his first chapter the author gives a concise account of the engineering and construction industry. He then proceeds to deal in successive chapters with the source of American law and courts; evidence, expert testimony and ethics; contracts and their discharge; business organisation; real property; the law of tort and agency; sales; construction contracts, and steps leading to the "award" of contracts; specifications; insurance and workmen's compensation. In certain appendices he sets forth a number of forms of contract.

Chapter IV relates to contracts. The reader will here find a useful summary of the law which applies to the subject matter of contracts. The author also deals with the "consideration"—an essential part of every contract which can be enforced in law—and points out that certain contracts must be reduced into writing. In this regard all the States of the Union have followed the law of England—a law which is to be found in a Statute passed in the days of Charles II. This chapter concludes with the reports of a number of cases which serve to illustrate the principles enunciated by the author.

One notes in many cases cited a tendency on the part of American judges to depart from rules long observed in English courts. For instance, the author quotes one case from Maryland, in which it was laid down that "in a building contract, where the contractor in good faith performs all that the contract requires, though not at the time or in the manner required, but substantially as agreed, except in respect of those things which he is prevented from performing through the breach or default of the owner, and the owner has received the fruits of the contractor's work, material and labor (*sic.*), the contractor is entitled to recover, since full performance has failed in those things which are not of the essence of the contract, and since otherwise there would be a forfeiture of the contractor's work, labor and material to the unjust enrichment of the owner."

It is doubtful whether this principle would be recognised by an English judge. In England the contractor is held bound to do what he undertakes. The question, however, is for all practical purposes academic even (we may suppose) in the United States. No contractor nowadays would bind himself to do all or get nothing for his pains. The form of contract usually entered into provides for payment as the work proceeds on the certificate of the engineer.

The author deals in one place with "Engineers in Courts of Law," quoting from a paper which William J. McAlpine presented before the American Society of Civil Engineers so long ago as 1870. The following extract from this paper is worthy of the attention of any engineer who is asked to give evidence in one of our own courts of justice:—

"The Court always understands that an engineer, when called upon the stand as a witness, has been previously adviser in regard to the professional questions upon which his direct examination will be made, and that he has prepared himself by study and reasoning to apply to the case in hand all of the scientific principles which are necessary to elucidate it.

"If he is a true man (to his profession) he will always give the results of his study, whether it bears for or against the side upon which he may happen to be called.

"His mission, and his profession, is simply the elucidation of truth."

Some interesting forms of contract are referred to in Chapter X, which relates to construction contracts. It is here pointed out that in America (as in England) the "lump sum" contract became unpopular in the period following World War II, costs being so uncertain that contractors did not care to bid. An objection to the cost-plus-a-percentage of cost contract, namely, that the owner may feel that the contractor has no inducement to keep costs down is sought to be overcome in what is called a cost-plus-a-fixed-fee contract. Here the fee to be earned does not vary with the work. This form was much used in Government work during the World War II and also on private work thereafter. During the unsettled conditions following the war, work has often been done on the terms of what is described as a "management contract." In this case an experienced person contracts with the owner to manage the construction of the project. He does not necessarily bring all or even part of his organisation (if he has one) to perform the work. He lets sub-contracts for the various subdivisions of the project, supervises performance, purchases materials, and (generally) hires the labour. His position, of course, is that of an independent contractor.

In dealing with "Specifications," the author adopts the very sensible plan of setting out (in Chapter XII) the specifications for a great aqueduct in California, adding explanatory notes when necessary, and interpolating alternative clauses. Particular interest attaches to the paragraphs which define and limit the powers of the engineer. In the next chapter he sets forth a number of paragraphs from various forms of "Detail Specifications." We cannot but think that a perusal of these pages might suggest some interesting points to him who is drafting a specification on this side of the Atlantic.

Crude Oils: Chemical and Physical Properties. Edited by B. T. Brooks and A. E. Dunstan. London: Oxford University Press, Amen House, Warwick Square, E.C.4. Price 48s.

This work comprises the first part of Volume V in the well-known series, "The Science of Petroleum." It covers the various sources of crude oils and the chemical and physical properties of petroleum hydrocarbons. The first four volumes in this series were compiled as far back as 1937, and in view of the vast progress that has been made in handling petroleum since that time, it was considered necessary to issue supplementary volumes to include the chief advances made. In the chapter on U.S.A. oils, the analyses of several hundred crude oils are summarised by an official of the American Bureau of Mines. Because such analyses do not contain sufficient information to meet all requirements, they have been supplemented when possible by more detailed data regarding the composition and properties of crude oil fractions.

Within the space available it has not been possible to include analyses for crude oils from each of the many thousands of oilfields and producing horizons in the U.S.A. A selection has, however, been made on the basis of total production in 1945 and on estimated reserves. The latter include only those oils that can be reasonably expected to be ultimately recovered by known production methods. The fields thus selected represent 76·4 per cent of the total U.S.A. production in 1945, and 82 per cent of the estimated reserves at that time. In Saudi Arabia crude oils were first discovered in 1935 and since then numerous wells have been drilled in different localities. The book describes the properties of the oils from these wells, much of the information being presented in tabulated form. These Arabian crude oils are said to offer considerable flexibility to the refiner in manufacturing petroleum products to meet his particular needs. A description

is given of the types of crude oil found in Bahrein Island, in the Persian Gulf. This oil is commonly regarded as an intermediate base crude, its light distillate products being predominantly paraffinic, and it can generally be refined to yield the whole range of petroleum products. The properties of the various products obtainable—from petrol to asphalt—are given in a comprehensive table.

For several years crude oil production in the Middle East has been established as the second largest outside the U.S.A. and in this volume a description is given of present-day operating conditions in the oilfields of Iran, Iraq and Egypt, while in several useful tables production figures and properties of the oil products are quoted. The characteristics of typical oil samples from the different oilfields of Venezuela are recorded in one table, and it is somewhat surprising to note that, although these oilfields have a production second only to those of the U.S.A., very little additional data on them are quoted. In a chapter on the evaluation of crude oils it is pointed out that while it is possible to produce any type of refined product from any crude oil, it is often uneconomic to do so. According to the book, the modern method of oil evaluation is designed to enable the refiners to judge the suitability of a crude oil for use in a particular refining process. Recent economic developments in the petroleum industry are reviewed in a chapter which covers growth of reserves, uptrend in production, developments in refining, demand and supply, and finance. Nearly three-quarters of the volume is devoted to the chemistry of petroleum and this section, therefore, although recording the latest information available, is likely to be of interest chiefly to scientists. In common with the earlier volumes in this series, the book is well printed, neatly bound and is adequately illustrated with drawings and graphs.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

REACTIVE FORCE IN A TURBINE NOZZLE

Sir,—I am much obliged to Mr. Schönning for his letter, which appears in your issue of March 2nd, pointing out an appreciable simplification of the formula, which I quoted in my letter of January 19th. Mr. Schönning's formula shows the way to an alternative expression, for the critical reactive force, of even greater simplicity, namely: γP_2, where P_2 is the pressure at the nozzle throat.

A. C. Hutchinson

Bedford, March 6th.

EARLY ELECTRICAL APPARATUS

Sir,—For some years we have been gathering together representative examples of the early electrical manufactures of Crompton and Co. for inclusion in an historic collection established at our Chelmsford works. The collection is largely the outcome of years of enthusiastic searching in this country and abroad by the late Mr. J. H. Johnson. There are, however, still a number of gaps, and we should welcome, and be most grateful for, information from any of your readers who could help us in our search for equipment manufactured by Crompton and Co. in the period 1878 to about 1909. We particularly desire to secure the following:—

(*a*) Crompton Barton Harris d.c. circuit breaker, 1901.

(*b*) "Dix" gravity circuit breaker, early 1890s.

(*c*) "Hedgehog" transformer, about 1888.

(*d*) Domestic electrical heating and cooking apparatus of all types, 1891–1899.

(*e*) Arc lamps, single and double-carbon, open type and enclosed type, and flame arc lamp, 1878 onwards.

(*f*) Horizontal d.c. generator, four-pole, recognisable by brushes spaced at 90 deg., type D.29, &c., 1890–1899.

(*g*) Two-pole smooth-core drum-wound armature, type D.104, d.c. generator or motor, 1897.

(*h*) Direct current ceiling fan with two blades, 1900.

(*j*) D'Arsonval "trombone" galvanometer.

(*k*) Pyrometer indicator and couple, early 1900s.

We are most anxious to make the collection at Chelmsford completely representative of the works of one of the pioneers in electrical engineering, and to this end we invite the co-operation and help of your readers.

Crompton Parkinson, Ltd.
H. Fawcett, Secretary

London, W.C.2, March 6th.

The Gas Council Report

The first annual report of the Gas Council was published this week simultaneously with the reports of the twelve Area Gas Boards. This report covers the activities of the Council from the vesting date, May 1, 1949, to March 31, 1950, as well as the preparatory period between July 30, 1948, and May 1, 1949. The reports of the Area Boards also cover the period from the constitution of each Board to March 31, 1950.

Although the report of the Council covers the period from July 30, 1948, to March 31, 1950, the accounts are for the eleven months to the latter date. Similarly, the first reports of the Area Boards cover the period from their constitution, while their accounts are for the eleven months. Expenditure incurred before vesting date (May 1, 1949) is, however, included in the accounts. During the period under review eight of the Area Boards showed surpluses and four deficiencies, the aggregate result of the operations of the Boards, after providing £250,000 towards the Central Guarantee Fund, which the Gas Council is required to establish, being a deficiency of £10,579. On the revenue account of the Gas Council, however, there was a balance of £13,242, and thus for the industry as a whole there was a small surplus of £2663. In the case of six Area Boards their surpluses permitted transfers totalling £370,000 to be made to reserve funds.

The gross revenue for the period of eleven months totalled £192·49 million, which means that, in a full year, the gross revenue should be about £210 million. Capital liabilities of the Boards are stated to be £264·6 million.

During the period under review 2131 million therms of gas were sold to just over 11,874,800 consumers, and the total revenue for all the Boards from these sales was £111·4 million. The number of consumers since vesting date had increased by 137,750 and the sales of gas were about 6 per cent higher than in the previous corresponding period. Of the consumers of gas, 119,830 were industrial establishments.

For the whole of Britain the average price per therm of gas sold for all purposes was 12·55d., and it ranged from 8·4d. to 11·78d. in the North and from 14·16d. to 15·59d. in the South of England. In Scotland the average price per therm was 12·02d. and in Wales 13·65d.

The average income per therm of gas supplied through slot meters was 1s. 2¼d.; through ordinary meters for domestic and other purposes 1s. 1¼d.; for industrial purposes 9¼d., and for street lighting 8d. The cost of gas made and purchased was £113 million, an average cost of 7·98d. per therm of gas sold, and the report points out that the gross cost of gas-making almost exactly equalled the revenue received from its sales. Raw materials used for gas-making cost £82·4 million, of which some 23,361,100 tons of coal cost £73·9 million. In addition to gas manufactured in their own works, eight of the Area Boards purchased 55,330 million cubic feet of gas from coke ovens.

A Gas Council Coke Committee has been established for co-operation between the Gas Boards on coke production and marketing, and manufacture of coke in the eleven months totalled 11,026,400 tons and of breeze 2,383,000 tons. Sales of coke and breeze, which brought in some £36·1 million, were 8,845,039 tons and 1,201,440 tons respectively, the remainder being used for the manufacture of water gas and for steam raising.

Production of the other main by-products from gas manufacture in the eleven months totalled 1,567,093 tons of crude tar, 23,648,700 gallons of crude benzole, 239,900 tons of ammoniacal liquor and 66,500 tons of sulphate of ammonia, and 193,900 tons of spent oxide. These other by-products brought in a net income of £6 million.

Conference on Diesel Locomotive Productivity Report

In "A Seven-Day Journal" for December 22nd last we noted that the Internal Combustion Group of the Locomotive Manufacturers' Association of Great Britain had started action on the report of the Diesel Locomotive Productivity Team, which visited the U.S.A. last year. Arrangements have now been completed for the holding of a conference at Blackpool on Tuesday next, March 20th, to enable free discussion amongst delegates from all levels of industry. The conference is to be divided into syndicates covering the recommendations contained in the report, and these syndicates will each in turn report to a meeting of the delegates at the conference for full debate. An outline of the recommendations put forward in the report was given in our issue of December 15th last. They covered a wide field of the industry from market research to workshop control and designing for productivity. The Internal Combustion Group hopes that by means of the conference a frank discussion on the report will be promoted, so that further action may be decided upon to obtain the fullest possible benefit from the detailed investigation of the American industry which was made by the British team.

Launch of the "Ucayali"

The first of two twin-screw shallow-draught river vessels, which are under construction for the Peruvian Government, was launched on March 7th from the Woolston works of the builders, John I. Thornycroft and Co., Ltd. The vessel was named "Ucayali" by the wife of the Peruvian ambassador, Her Excellency Señora Teresa de Rivera Schreiber. The vessel, which, it is understood, is the first naval ship for a foreign Power to be launched in this country since the war, has a waterline length of 154ft 9in, a beam of 32ft and a load displacement of 350 tons on a draught of 4ft. It is mainly of riveted construction, being safeguarded against corrosion by the extensive use of galvanising, and, to help to achieve the light draught, the whole of the superstructure has been built of aluminium-magnesium alloy. Two British Polar diesel engines, each developing 400 b.h.p. at 350 r.p.m., are to be installed as the main propulsion units and it is estimated that this power is sufficient to give the vessel a speed of 12 knots. The accommodation for the crew, consisting of four officers, six petty officers and thirty ratings, has been designed to suit the climatic conditions. The armament to be carried has not been finally approved, but it is understood that some 3in guns and 20mm weapons will be mounted. Both the "Ucayali" and her sister ship "Marañon" are intended for service on the River Amazon and its tributaries, to carry out police patrol duties as units of the Peruvian Navy. It is expected to complete both patrol vessels by July next, when they will make the long voyage of over 4000 miles, under their own power, to their base at Iquitos, Peru, some 2200 miles up the Amazon.

Education for Industry*

By SIR CLAUDE GIBB

ONE thing that is essential in Great Britain to-day is a marked increase in the number and quality of technically trained people, regardless of where they receive their training. Sir Ewart Smith, in his admirable address to the British Association last year, drew attention to the relative numbers of technical graduates in the United States of America and in this country. Industry must expand to meet the present-day demands upon it, and I see no likelihood of those demands diminishing over a great many years. It is essential that more and more labour-saving equipment be designed, developed and brought into normal production. If this nation is to survive, it must be by virtue of a marked increase in output per man-year employed in industry, and that increase can only be achieved by a greater degree of mechanisation, thus calling for additional technical men to design and develop the equipment, and, having installed it, to ensure its satisfactory operation. We must have a greater proportion of technically trained men to actual machine operators in our future industrial plants. It is my belief that the higher proportion of technically trained men on the payrolls in the United States of America has been the main factor in the greater productivity per man-year in America when compared with this country.

In what the Americans call "custom-built" and in this country we call "one-offs," the United States does not lead this country in design, in delivery period or in cost of manufacture. With large electrical equipment, such as turbo-generators and the like, this country has no difficulty in competing with the U.S.A. It is in the heavy electrical industry that there has been a big increase in the intake of technically trained men, and it is in that industry that there is a high proportion of technical men in relation to total personnel. I am certain that that fact is not just a coincidence.

Technical colleges and the universities have performed almost a miracle in the tremendous expansion they have achieved since the end of the late war, and to them industry expresses its deep thanks and appreciation. But industry also says to them that a doubling of graduate output having been achieved, they must not now rest content and merely go on producing that increased number of trained men. Industry needs more technically trained men to-day and will go on demanding more and more when there is a wider appreciation in industry of the advantages in productivity and in product quality which inevitably arises from a wider employment of the technically trained man.

I beg of you as representing the major technical institutions in this country that you prepare for an even greater expansion than you have made in the past five years. You have been, and still are, working under the greatest of difficulties, not only of student but also of staff accommodation. It must be your aim, backed by industry, to press for a greater allocation of building facilities to be made available for your expansion.

In certain circles there has been a considerable pressure of recent years for the creation in this country of educational institutions on the lines of the Massachusetts Institute of Technology or the technical high schools of Germany and Switzerland. I believe the pressure for that type of school to be based upon a false conception of what industry requires of its technically trained men. If there is one criticism that I would make of Continental engineering, it is the belief in the truth of mathematics. Starting upon the series of assumptions, the mathematical solution worked out to the fifth place of decimals is so beautiful and satisfying as often to cause the fact to be overlooked that the basis was assumption. The advice that I have frequently given young men is to let mathematics guide experiments, but if the experiments do not agree with mathematics, then always to suspect the mathematics first.

Britain has led, and still leads, in fundamental research, and, that being so, it seems to be justification for claiming that our basis of education is sound. But where Britain has lagged is in the application of that research, and the reason for this I believe to be twofold; first, the lack of technical men in industry with a receptive mind and the willingness to try any new theory or development, and, secondly, a gap in thought or in geographic location between the research team and those men who must take responsibility for the final design should some new thoughts be incorporated.

Bringing the commercial designer into closer contact with the research worker, and having amongst those responsible for the direction of industry a greater appreciation of the advantages to be gained from fundamental research, is the solution to our increased productivity much more than the slavish copying of a system which, in my judgment, has no advantages over our present practice in this country. What is needed to make our educational system superior to that either of the Continent or in the United States is more money for better housing of staff and students and for better teaching and research equipment.

The Education Act of 1944 laid down ideals at which to aim, but they could not have been considered in terms of bricks and mortar when the Act was drafted. The broad planning of the 1944 Act has proved to be too ambitious in the light of post-war demands upon materials and men. But I suggest that by inspiration and improvisation there is much more that can be done even with present accommodation and equipment.

I am certain that what Britain is missing to-day—far more than shortages in materials—is a serious shortage in inspiration, in enthusiasm. What is wrong with us? This lack of zest is not confined to any class, walk, rank or strata of society. It is almost universal. We have lost pride—national and individual pride. We used to be proud to be British. We had an intense pride in craftsmanship.

Fifty years ago there began the great revolution in Britain. A revolution so gradual as hardly to be noticeable, but nevertheless revolution more than evolution. That revolution has been speeded up by two World Wars and is still proceeding. In that revolution we have lost much, but gained more. We have, however, lost one thing that may well undo everything good that has come from the last fifty years. Lost pride can and will bring to naught all that has been gained.

Let us start now to safeguard the benefits of this great revolution. You, gentlemen, can and must play a major part in this rebirth of a nation, for it is nothing less. Create in your students a pride in achievement; drive home the fact that one can only get out of life what you put into it. Make them realise that you cannot get "owt for nowt." Build up a receptiveness to learn—not only from the present, but from the past. Convince them that learning does not cease upon graduating, but is only just beginning and continues right through life. Inspiration or leadership can only come from the top layers in industry or in education. Enthusiasm, receptiveness and hard work could restore Britain in a very short time to her former great position. In so doing, the shortages of material and men now preventing you from having the accommodation and equipment you require would rapidly disappear.

I will give you a target for your achievement. It is to provide industry with technically trained men amounting to 20 per cent of the total payroll. The percentage will vary from one industry to another, but 20 per cent is, I believe, about the average required. This figure includes the accountant, the man of commerce and those requiring technical education in the widest sense.

Analysing the requirements of a works with a payroll of about 5000 engaged in engineering, the distribution of qualifications is:—

Honours degree or post-graduate training ...	60
Pass degree, Diploma or Higher National Certificate	400
Minimum qualification, Ordinary National Certificate	450
	910

For every 100 lads reaching school leaving age, I want at least ten to reach the equivalent of the Ordinary National Certificate and another nine or ten to take the Higher National or equivalent Diploma or Pass degree. At least one, and preferably two, should go on and do post-graduate work or take an honours degree.

My experience shows that of those hundred lads leaving school, at least ten are incapable of writing a readable letter or doing the simplest sum in arithmetic five years after leaving school. For that tragedy and waste of teaching time I blame mostly home surroundings and a "don't care" attitude on the part of the parents.

And yet many of those almost illiterates can be trained to become excellent craftsmen; and certainly they can teach themselves to become experts in the intricacies of football pools! In the main, they are not unteachable; in most cases they were never interested enough to attempt to learn. They had no pride in their school life and it will be almost a miracle if they develop a pride in anything worthwhile at a later date. That miracle, however, can be brought about, and the response to cheerful and colourful surroundings in industry can be quite remarkable.

Only when a man works because he is interested in his job and not because he has to do so to live will there be that restoration of Britain's greatness and leadership in world affairs. Inspiration, enthusiasm and leadership in education and industry can create the surroundings and atmosphere necessary to safeguard the good things arising from Britain's revolution. Technical education must be the background of our leaders of industry in the future.

* Association of Technical Institutions, February 23rd. Presidential Address. Abstracts.

The Institution of Naval Architects

No. I

THE annual spring meetings of the Institution of Naval Architects, which opened on Wednesday, March 14th, on board the Headquarters Ship "Wellington" of the Honourable Company of Master Mariners, Victoria Embankment, London, were presided over by Admiral of the Fleet Viscount Cunningham.

The annual report of the Council was presented and adopted and a small increase in membership recorded. The accounts, presented by the treasurer, indicated a satisfactory financial position.

The Premiums for 1950 were awarded to Mr. E. Ower and Mr. C. H. Burge, for their joint paper "Funnel Design and Smoke Abatement."

The Wakeham Prize was presented to Mr. D. J. Doust for his paper, "Design-Analysis Diagrams for Wide-Bladed Propellers."

The Duke of Northumberland Prize was awarded to Mr. James Glasgow, of Barrow-in-Furness Technical College.

The results of the 1950 scholarship examinations were given and also a list of scholarships for 1951.

Admiral of the Fleet Viscount Cunningham then gave his Presidential Address, abstracts from which are printed below:

It has been a great privilege that, during the past three years of my presidency, we should have held all our spring meetings on board the "Wellington." But I must give the Master Mariners warning that this happy state of affairs cannot continue indefinitely. The fact is, the Institution of Naval Architects has prepared plans for building its own lecture hall. There formerly stood at the back of the I.N.A. building a house which was demolished in 1940 and the Council thought that this section of our property might usefully be rebuilt as a lecture hall. Our architects were consulted and suitable designs were approved, and as soon as the necessary licence can be obtained we hope to go ahead with the work. I would add that we hope to meet the cost of this enlargement of our premises from our own resources.

The past year has seen a considerable change in the extent of orders placed for new warships, and also in the importance attached to the acceleration of their construction. The larger vessels for which orders have been placed—the frigates—will serve, when complete, to increase greatly the anti-submarine defences of our seaborne trade. The urgent need for such vessels was a matter to which I made reference last year. Of equal importance to the protection of our merchant ships at sea is the keeping open of channels so that they may enter and leave port in safety. This need will be met by the coastal and inshore minesweepers of which a considerable number has been ordered.

With the placing of these orders has come also a hastening in the progress of those already under construction by raising the priority of warships as compared with merchant ship construction. Similarly, in the engineering and electrical industries, provision of equipment for the naval vessel now has priority over all work for the home market and equal priority with work that represents hard currency exports. Considerable attention has been given during the year to the state of readiness of the Reserve Fleet. Many ships have been refitted and some modernised or converted to meet other requirements. The Admiralty has decided to convert the Cruiser "Cumberland" into a special trials ship for the purpose of carrying out sea trials on new naval equipment. It is of the highest importance that it should be fully tested under seagoing conditions before being finally passed for fitting in the Fleet. One of the items of equipment to be fitted in "Cumberland" is a Denny-Brown ship stabiliser. Last year I referred to the important experiments the Admiralty were about to carry out by loading a destroyer in dock up to the point of structural failure and measuring stress distribution. These trials have now been completed and I hope the Admiralty will allow a paper to be read before the Institution giving the results of this investigation so that the valuable information gained will become available to the shipbuilding industry.

During the year a Task Force has been set up under the North Atlantic Treaty Organisation to consider how best to use the shipbuilding capacity of the North Atlantic Powers in order to build up a strong naval defence force. This country has taken a leading part in these deliberations and the discussions have covered not only shipbuilding capacity, but also the types of ships and craft to be built.

The Tonnage Measurement Laws Committee set up last year by the Council has been active, and I would like to thank them for the hard work and very promising and sensible proposals they have put forward. They have achieved unanimity of opinion from all technical interests concerned in that part of the regulations dealing with propelling power allowance, and have obtained the approval of the General Council of British Shipping. A memorandum dealing with this particular aspect of the whole question has been recently forwarded to the Minister of Transport, who received a deputation of the Presidents of the four institutions concerned—ourselves, the Institute of Marine Engineers, the Institution of Engineers and Shipbuilders in Scotland, and the North-East Coast Institution of Engineers and Shipbuilders—and also the Chairman of the General Council of British Shipping. The hardest task before the Committee is to get similar unanimity in complete revision of the regulations. The Committee, however, represents different interests, and its members are unanimous in favour of a proposition which has been worked out in very great detail.

Another matter is the report of the National Advisory Council for Industry and Commerce dealing with the future development of higher technological education. The Council have sent a letter to the Minister of Education setting out objections to some of the proposals made. The subject is highly controversial and complex, but it seems to us that the National Advisory Council's recommendations for higher technological education would result in too much centralisation of control, and a certain duplication of function, together with possibly overmuch Government and academic guidance in matters which are principally the concern of the professional and technical institutions. We hope that the scheme put before the Minister may undergo some modification in the direction we have indicated, before being brought into force.

The Lord Mayor has kindly consented to open the forthcoming International Conference of Naval Architects and Marine Engineers at the Central Hall, Westminster. We are co-operating with the Institute of Marine Engineers, who are acting jointly with us as hosts in London, and with the Institution of Engineers and Shipbuilders in Scotland and the North-East Coast Institution of Engineers and Shipbuilders, who similarly have undertaken to organise the conference proceedings in Glasgow and Newcastle-upon-Tyne.

I now have the pleasant task of asking this meeting to approve the nomination of my successor, Viscount Runciman of Doxford, O.B.E., A.F.C., D.C.L.

(*To be continued*)

Annual Report on Road Research

THE Department of Scientific and Industrial Research has just published the report of the Road Research Board and the Director of Road Research for the year 1949 (H.M.S.O., price 3s. 6d.). The Board's report provides, in effect, a summary of the policy and activities of the Road Research Laboratory, and is followed by the more detailed information given in the Director's report, which is divided into the two subjects of "Materials and Methods of Construction" and "Road Safety and Traffic Flow." Much of the information given in the report has not appeared before.

The section on materials and methods of construction is concerned with the various experiments in progress during 1949 on concrete and bituminous surfacings, and also includes notes on subjects such as soil compaction, road construction on peat, theories of moisture distribution in soil, and theories of pavement design. There is an appendix giving details of the experiments which the laboratory is carrying out on public highways, and information on the economics of bituminous construction. It is pointed out, however, that the continuing curtailment of road works has meant that there is still a dearth of facilities for those types of full-scale experiment that require a site where new construction is in progress. It is earnestly hoped, the report states, that some way will be found of providing sites for these experiments soon, well in advance of the large amount of new road construction that will inevitably be necessary, so that reliable results will be available at the time when they are most required.

The work on road safety and traffic flow is noteworthy for the wide range of subjects which have been studied, ranging from investigations of vehicle and street lighting, for instance, to tests of the reaction times of drivers. Analyses are given of the various studies undertaken during the year, which deduce the effect on accidents of such measures as the prohibition of waiting in certain London streets, and the "zebra" marking of pedestrian crossings. One of the results which has been obtained from these studies is the increase in accidents due to skidding when roads are wet, those sections of road having low sideway force coefficients having abnormally higher accident rates in wet weather. An improvement in the behaviour of vehicles on slippery wet surfaces was obtained by using tyres with steel inserts in the tyre treads. It has also been shown that, on a good road surface, with new cars having carefully adjusted brakes, the shortest stopping distances which could be obtained were approximately those quoted in the Highway Code, but such stopping distances could not normally be expected from the average driver and vehicle. It is also pointed out in the report that the practice of assigning a first cause is liable to lead to erroneous conclusions regarding the nature of road accidents.

The Atomic Energy Research Establishment*

By SIR JOHN COCKCROFT, C.B.E., F.R.S.†

THE Atomic Energy Research Establishment was founded five years ago. It is therefore appropriate to take stock of the progress that has been made and to ask what the country has gained for the large investment of money, labour and scientific effort which has been made.

The establishment was built on the foundation of the Royal Air Force station at Harwell. This site was chosen to provide a flying start in the way of roads, services and permanent buildings. The scientific staff of the establishment has been built up round the nucleus of the wartime teams working at Chalk River in Canada, and at Los Alamos and Berkeley in the United States. Most of this staff came from universities during the war and this has given a rather unusual character to the staff at Harwell.

If we look at our equipment we can say that all of it is working, and most of it has been up to the expectations of the designers. The low power pile went into operation fifteen months after the first workmen entered the site; it was followed by the high-power pile nine months later. Both piles have operated on a twenty-four-hour basis since that time and have been shut down only for maintenance. The smaller pile controls the quality of all the important materials used in atomic pile technology; it measures some important properties of atomic nuclei; it provides neutrons for the biological experiments of the Medical Research Council unit. The high-power pile produces radio-active elements for shipment to hospitals, research institutions and universities. Shipments made to all countries of the Commonwealth and Western Europe from Harwell have now risen to over 500 a month and the numbers are still rising.

The high-power pile does other things; it is a development unit in pile technology—we have tried to solve there the problems which will be met with in the still larger piles in Cumberland and in the future power-producing piles. We use it also as an important research tool for physicists, chemists and biologists.

The cyclotron is at present the most powerful in Europe and produces in good measure streams of protons and neutrons having energies of up to 180 million volts. We use these streams of energetic particles to try to determine the nature of the forces which hold atomic nuclei together—this is the central problem of physics to-day. We have also developed at Harwell a new kind of atomic particle accelerator in which electrons are made to surf ride in front of an electric wave which travels down a hollow tube. The wave travels faster and faster and so do the electrons. In this way we have built remarkably compact generators for 4 million volts and 10-million-volt X-rays. Six of these units have been ordered by the Ministry of Health for supervoltage therapy and one 10-million-volt unit has just been completed by industry for medical research. We are now extending the energies of these machines by another large factor. We use them for investigation of the technologically important properties of atomic nuclei—properties of importance in the design of power-producing piles. But they have other important potential uses—just possibly to food preservation.

The most important effect of Harwell's work on the outer world has been through the production of radio-active isotopes. They are already being used in industry for a number of industrial operations; they are used for the accurate and continuous measurement of materials rolled out by mills—materials such as steel, brass, cardboard, paper and polythene. Radio-active cobalt or tantalum is produced in the form of small cylinders for the testing of welds in boilers and other plants; this is a cheap form of X-ray set and we are now sending out fifty units a month for this work. Radio-active gases are used to study ventilation problems of factories. Problems of wear and corrosion can be studied by making the materials of paint or cylinder walls or piston rings or lubricant, radio-active, since wear of the parts can be so easily detected and measured.

These applications are fairly obvious and straightforward, but we believe that much more use can be made by industry of radio-elements. As an example, the very important synthesis of hydro-carbon oils from CO and hydrogen in the pressure of a catalyst is very imperfectly understood. The incorporation of a tracer in the catalyst enables the chemical engineer to test theories of the reaction and might well lead to new developments. At Harwell we are engaged in a new process for the separation of two materials, hafnium and zirconium, which are inseparable by normal chemical operations. To test the efficiency of separation of the process continuously we make one of the components slightly radio-active. We can, therefore, tell at once if any part of the zirconium goes down the hafnium channel and *vice versa*.

There are two major groups of problems in the development of nuclear power, the technological and the economic problems. The essential technological problems of nuclear power are to develop the heat at a high temperature in uranium metal rods in a pile and to transfer that heat to a conventional power plant—which will be a steam boiler and steam turbo-generator in the first plants. The physical and engineering problems of design are difficult but appear to be soluble. The most difficult problems are metallurgical. This is because of the objectionable metallurgical characteristics of uranium metal and the peculiar intolerance of atomic piles to conventional metals such as steel—which absorbs too many neutrons. We are being driven, therefore, to sheath—or can—our uranium metal with the new metals such as beryllium or zirconium for which a new metallurgy has to be developed, but the achievement of reliable solutions is bound to take time. In order to provide for this work we have had to provide facilities for producing beryllia and beryllium of high purity in this country. Incidentally, we are also providing for a supply to industry of the important beryllium copper.

Our main effort is at present centred on a design and feasibility study of an experimental power producer. The reactor will use enriched uranium and heat will be transferred to a steam boiler by compressed gas. Several industrial firms are collaborating with us in this first project and we are aiming at producing cost estimates and obtaining approval for construction by the middle of the year. If this reactor is built, it will give us operating experience and experience in the metallurgical stability of our fuel units. We shall then have some firm basis for estimating the future of nuclear power. This reactor will also serve as a prototype for a power unit which we hope will be small enough to serve as a ship propulsion unit for special purposes. It might also serve as a pilot unit on which we could design a much larger central station power unit suitable as an experimental nuclear power station for the British Electricity Authority. We are in touch with the Ministry of Fuel and Power, the British Electricity Authority and industry on this.

The longer term and more adventurous approach to nuclear power is through the construction of breeder reactors to use uranium 150 times more efficiently than the first type of reactor. Breeder reactors require a starting charge of highly enriched uranium or plutonium. We have made a start on theoretical and experimental studies which could lead to the construction of such reactors, when the fissile material is available. The breeding of nuclear fuel requires also the active support of our chemists and chemical engineers to separate the new bred fuel from the primary fuel. Some years ago these problems looked very difficult, but with developing knowledge they are beginning to appear tractable. It would be dangerous to make any prediction as to the cost of nuclear power before we have had experience of operating pilot plants. Such calculations as we have been able to make so far suggest that power developed from reactors using natural uranium and burning only 1 part in 300 to 1 part in 100 of the uranium might just about break even with the cost of power from coal if the cost of uranium does not go far beyond present costs. However, to supply nuclear power on a large scale with the low efficiency of utilisation will require the use of large quantities of uranium which can only be obtained from low-grade deposits. Experience is now being gained of the cost of extracting uranium from such deposits, but we are not yet in a position to predict future costs. Breeder reactors would require much less uranium if they were successful, but until we have operated experimental breeders we cannot predict costs.

Other possible industrial applications of atomic piles and their radiations are beginning to appear above the horizon. The intense pile radiation may have applications to the synthesis of complex chemical compounds—already some reactions are being studied on a small scale in the Harwell laboratories.

A quite substantial amount of effort goes into the investigation of the biological action of radiation, into possible antidotes to large doses of radiation, into the study of safe levels of radiation for occupational exposure and exposure of the population at large, and into the development of instruments for the control of exposure. The first part of this work is carried on by the Medical Research Council radio-biological research unit, which is situated at Harwell. It seems now to be fairly well established that radiation produces its harmful effects not by direct physical action on molecules of the body, but by indirect chemical effects—there is, therefore, some hope of influencing the course of events. As a by-product to these health studies we give advice to the Civil Defence authorities on how to deal with radiological hazards which would arise from an attack by atomic bombs.

* Abstract of an address to the Parliamentary and Scientific Committee. February 20, 1951.

† Director, Atomic Energy Research Establishment, Harwell.

Cast Milling Cutters

LAST week there was demonstrated at the works of B.S.A. Tools, Ltd., Marston Green, Birmingham, a range of cast milling cutters which the company is now manufacturing and proposes to place on the market in the near future. These new tools are cast to precision limits by a process which has been developed by the firm, and with this process it is as easy to produce cutters of complicated form as those of simple straightforward design. In fact, as the makers point out, the maximum advantage can be taken of the latest developments in cutter design without such an increase in production costs as would be met in the manufacture of cutters by conventional machining methods.

What is probably of equal importance from the national viewpoint is that the materials from which the cast cutters are made are based on a 1·3 per cent carbon, 13 per cent chromium alloy containing small amounts of tungsten and vanadium. There is a consequent saving of the alloying elements such as tungsten and molybdenum which are now in short supply. The steel used for the new cutters possesses excellent casting properties with complete freedom from massive segregation in the cutting teeth, provided due precautions are taken and the correct casting technique is used.

In the manufacture of the cutters the design of the pattern, composition of the mould, composition of the steel and the

pouring have to be carefully controlled and differ greatly from normal foundry procedure. In order to obtain a sound casting the design of the pattern and particularly the mould are of the utmost importance, and it is claimed that there is practically no tool shape the firm cannot produce by the process provided care and attention is given to a number of details.

It will be appreciated that with the introduction of the new process the tool designer has full scope to design cutters of the maximum efficiency without being subjected to limitations imposed by conventional methods of machining from the solid. The casting of the tools to close limits virtually eliminates machining other than finish grinding of the teeth. Such tools as milling cutters with alternate teeth having opposite helix angles can be made with no more difficulty than a cutter with identical teeth, and cutting teeth can be produced having any shape in any direction.

Comprehensive tests have been made with cast cutters on the machine lines in the B.S.A. and other works, and during the demonstration different machines in various parts of the works were shown on the production of standard parts using the cutters. It was shown that the new cutters were capable of removing stock at a rate as great, and in some cases greater, than standard 18/4/1 high-speed steel tools. With these cast tools it is, however, essential that a copious supply of cutting fluid should be maintained during machining.

The makers, as well as supplying finished cutters, are making castings available to members of the Milling Cutter and Reamer Association. These castings will be supplied in the annealed condition and, since the process eliminates all milling operations, soft machining operations only are necessary to produce the hole and keyway before the cutter is hardened and finish ground. In addition to manufacturing milling cutters by the new casting process, there have also been produced blanks for manufacture into thread rolls, special turning tools, inserts for broaches and extrusion die blanks.

At present some 500 to 600 blanks are being cast each week in a special department at the Marston Green Works, but when in a few weeks a balanced plant is in full production they will be made in much greater numbers.

Improvements at Euston Station

It is announced by the London Midland Region of British Railways that work is shortly to begin on a scheme of improvements at Euston Station, which will have far-reaching benefits on train operation. The work, which will take some two years to complete, will cost about £300,000.

Under the scheme, a new power-operated signalbox, with colour-light signalling and complete track circuiting, will replace Nos. 1, 2 and 3 signalboxes. The main line working at present controlled by No. 4 signalbox will be transferred to the new power-operated box, and the existing manual block working between Euston No. 2 and Camden No. 1 boxes abolished in favour of train describers. Position light dwarf signals will control all shunting movements, thus eliminating hand signalling and the need for verbal instructions to drivers, and ensuring that all movements are made under the protection and authority of fixed signals. This new signalling is designed to link up with the existing continuous colour-light signalling on the main lines between Euston Station and Sudbury junction.

After careful consideration of the difficulties of the restricted space outside Euston, it has been decided that the most suitable site for the proposed new power-operated box is just north of Hampstead Road bridge No. 5. Alterations to the connections to the down empty carriage line are necessary in order to give a clear space of sufficient size, and these in turn will call for alterations to the signalling at No. 4 box so as to maintain the existing standing room on the down empty carriage line, a factor of some importance in the clearing of empty stock trains from the station.

The existing permanent way in the area covered by the scheme is very complicated and contains eighteen diamond crossings, eleven of which are accompanied by inside or outside slip roads, two of them being double slips. Curvature is in many places sharper than 8 chains radius. These factors, combined with the weight of traffic, inevitably result in heavy maintenance commitments in an area where maintenance work is difficult to carry out because of the density of the traffic. The new lay-out will be much simpler, containing only five diamond crossings, two of which are to be single-slip roads, whilst the curvature will seldom be sharper than 10 chains radius.

Euston was not built for the long trains of the present day and this defect is a fundamental cause of serious terminal difficulties at this station. On the arrival side the platforms are of insufficient length to accommodate long trains, these frequently standing proud of the connections to other platforms. Thus a following arriving train often has to be held outside the station although the platform to which it is booked is unoccupied.

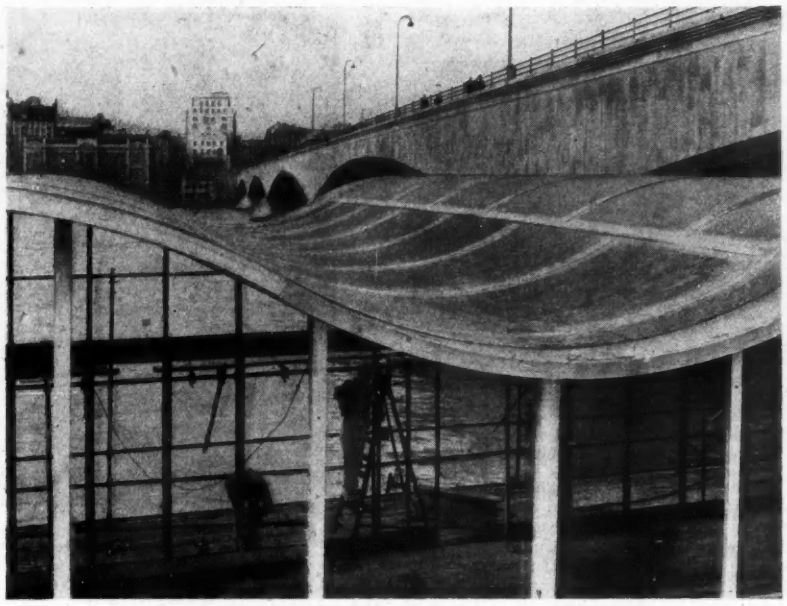
No major improvement hitherto was possible, as the piers of overbridge No. 3 at the north end of the station prevented respacing of the tracks to permit the platforms to be lengthened. The superstructure of this bridge has now reached the end of its useful life, and together with its piers will be removed.

The removal of this bridge will enable the lay-out of the connections to be simplified and the platforms to be lengthened.

An Aluminium Structural Panel

The use of aluminium alloy as a structural material is well exemplified by several of the buildings of the Festival of Britain site on the South Bank of the River Thames. An interesting example is the aluminium shell roof of the restaurant which has been constructed beside the river, and partly under one of the spans of Waterloo Bridge. This roof has been built up of panels, each 8ft by 4ft, and curved to a radius of 6ft 9in, and consisting of a 2in layer of baked cork slab glued between two sheets of 20 gauge aluminium alloy to Standard Specification N.S.3 (B.A. 60). These "sandwich" panels have been developed by Alphamin, Ltd., 4, Dunston Street, London, E.8, in conjunction with the British Aluminium Company, Ltd., Salisbury House, London Wall, London, E.C.2.

It is hoped that the properties of the "sandwich" panels will be suitable for structural uses such as curtain walling or "unit" construction. They can be up to 10ft by 4ft in size, and with a 2in thickness of cork have a thermal conductivity of 0·14 B.Th.U. per square foot per hour per degree Fahrenheit, equivalent to about 40in of brickwork, and a weight of 2·25 lb per square foot. The panels are joined together by riveted cover straps, or by an H-shaped extrusion riveted in the joint. We understand that interlocking joints are also being developed, and that for curtain walling the panels can be clipped to the steelwork.



ALUMINIUM SHELL ROOF AT FESTIVAL SITE

The roof referred to above has a span of 27ft. H-shaped extrusions were used in the three central joints of each span, to increase the structural strength, and cover straps were used elsewhere. The roof is shown in the accompanying illustration. A prototype bay was successfully tested to the required loading of 30 lb per square foot, equivalent to a total load of 5 tons on the bay. The building is curved in plan, which added to the complication of the work; there are nineteen bays, the supporting columns being at 14ft 2in centres at the front, and varying at the back owing to the curvature.

The columns are of tubular section, 3in in diameter, and a channel member, which is concealed by cover plates, transmits the roof load to them. The architects are Messrs. Fry, Drew and Partners.

A Small Layer Thickness Meter

Our illustration shows a new pocket-sized instrument designed for the measurement of non-ferrous layers on ferrous bases, and introduced by the General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2. The instrument has many industrial uses in engineering, paper-making, printing, metal finishing, foil-making, textiles and packaging. In determining the thickness of layers which are bonded to the base material the meter is used direct, but for such substances as paper, leather-cloth, foils electrical insulating cloths, &c., the material is tested in contact with any convenient iron or steel surface.

The instrument is self-contained and does not require an electrical supply. It is, in fact, a magnetic reluctometer which operates on the moving-iron principle. A shaped moving iron is mounted at the neutral axis of a powerful permanent magnet. One end of the magnet is fitted with a spherical pole-piece of hardened

steel which projects through the bakelite case of the instrument. The moving iron, which is spring controlled, has a partially suppressed zero position and takes up a position of equilibrium when the magnet and spring torques are equal and opposite. If, then, the spherical steel tip is placed on a ferrous plate, the magnetic flux distribution will be changed and the moving iron will take up a new position of equilibrium. Because of the suppression of the spring (which gives it a small torque when the instrument is at rest) small non-magnetic layers placed between the steel tip and the base will cause relatively large movements of the

LAYER THICKNESS METER

moving iron and the scale can be calibrated in terms of thickness of the non-magnetic layer.

Besides being used for absolute measurements, the meter can also be used as a comparator or limit gauge, by setting the pointer at the desired scale point when the instrument is placed on a known thickness. A useful characteristic of the instrument is that the pointer is locked automatically except when a small push button on the case is pressed. Measurements can, therefore, be made in out-of-the-way places such as in the corners of tanks or the undersides of steel plates.

The minimum sizes of ferrous base material on which the zero can satisfactorily be set are shown herewith :

Sheet : down to 0·01in thick and 2in square.

Strip : down to 0·0312in thick, 0·25in wide and 10in long.

Rod or tube : down to 0·75in diameter and 6in long.

Minimum concave radius : 3in.

Minimum convex radius : 0·375in.

The meter is available in three single-range forms of 0–5, 0–10 and 0–30 thousandths of an inch. It weighs 6 oz and its overall dimensions are 3½in by 2½in by 1½in.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 24, Victoria Street, London, S.W.1.

DIMENSIONS OF COMMON BUILDING BRICKS

No. 657 : 1950. It is a comparatively simple matter to specify dimensions for common clay building bricks, but it is much more difficult to define tolerances which meet an acceptable compromise between the user's wish for uniformity and the makers' need to allow for variations unavoidably arising in manufacture. The manner of specifying the dimensions given in previous editions has been abandoned, but the basic dimensions specified are still : length 8⅝in, width 4 1/16in, and two depths of 2⅜in and 2⅝in. The method of testing for compliance with these dimensions has been revised and is now based on maximum and minimum measurements when twenty-four bricks are placed in contact. Price 1s., post free.

PACKAGING : SEALING

No. 1133, Section 14. This Section of the Packaging Code contains sub-sections describing gummed paper tapes and gummed cambric tapes, as well as the various types of self-adhesive tapes. For the latter, detailed specifications are given as well as the usual descriptive matter and a number of tests related to these specifications are included in the appendices. Price 3s., post free.

Further Mechanical Aids for the Foundry*

By A. S. BEECH, M.I.Mech.E.†

MECHANISATION IN JOBBING FOUNDRIES

Medium Foundry.— Many foundrymen throughout the world still adhere to the theory that mechanisation methods can be applied only when the demand is for large numbers of castings off any given pattern, and they praise the efforts and results obtained in the production of repetition castings, but they still maintain that the jobbing side cannot be mechanised. As a result the jobbing shop, except in a few instances, lags behind.

Certainly, mechanisation or semi-mechanisation of the jobbing shop is a much more difficult problem to solve and will probably never be solved to the same extent as in the repetition shop, but a great deal can be done to lessen the laborious work in such shops which has been the rule in the past.

Fig. 1 indicates the lay-out for the manufacture of medium castings, ranging in weight from 1 to 12 cwt, all of a jobbing nature. It gives a very good general idea of what can be done to overcome the present world shortage of skilled moulders, and also to make foundries attractive to both the older and the younger generation.

If it is possible to cut out the donkey work by the use of electric horse-power, and, at the same time, leave the skill, such as pattern drawing, gating, patching, &c., to the individual moulder, and make his surroundings more congenial, youths, who are so badly needed in the foundries, will be attracted, and the output per man employed will advance rapidly.

Within six months of the installation of three mechanised plants at a works, twenty-five applications were received from youths for training. Previous to this there had not been one application for eighteen months.

The five jolt machines, shown in Fig. 1, were already in the foundry before the other part of the installation was considered, and will probably be replaced by automatic mechanical sand-ramming machines. One such sand rammer is already installed on the mechanical moulding side of the unit and is much more elastic in its application than the jolting machines.

At the present time, however, the moulds are rammed up on the jolt machines and by

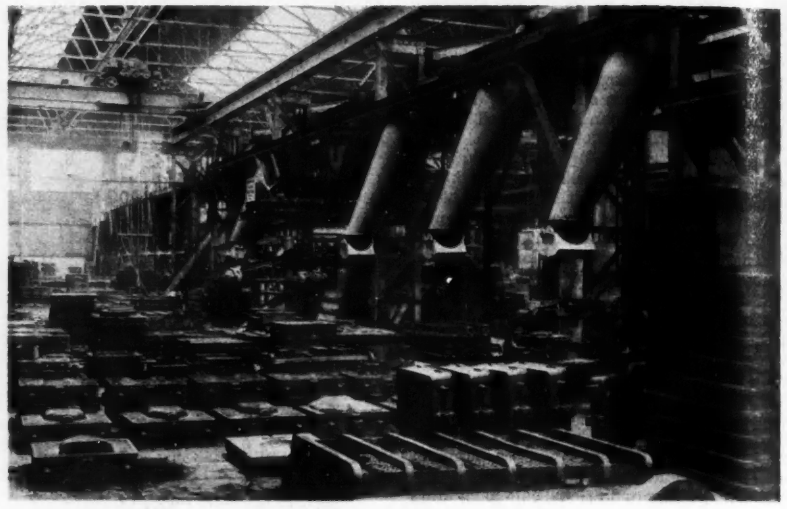


FIG. 1—*Mechanised Medium Foundry*

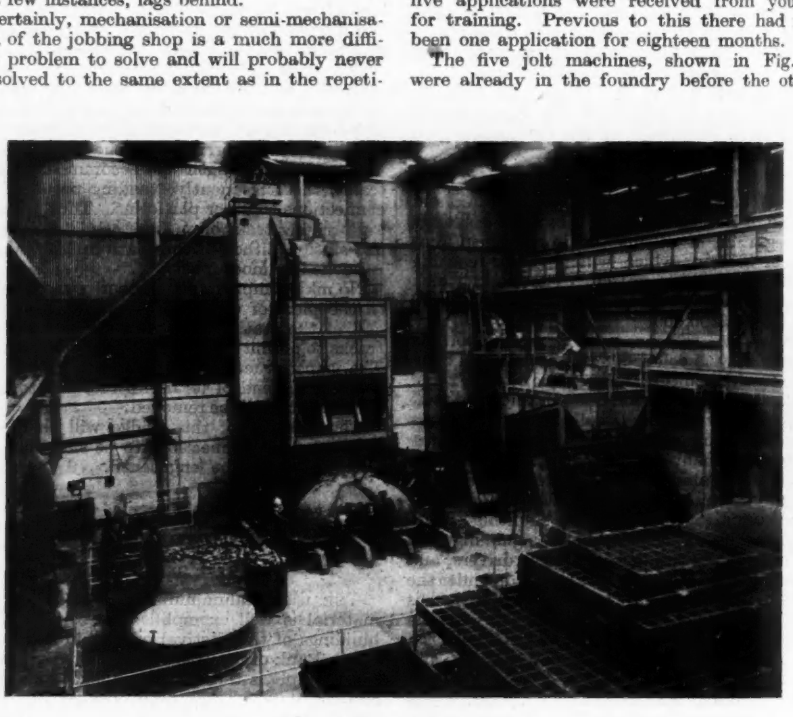


FIG. 2—*Mechanised Heavy Foundry*

*Institution of Mechanical Engineers, March 9th. Abstract.

†Chairman and Managing Director, Foundry Equipment, Ltd., Leighton Buzzard.

the sand rammer, and are transferred to the sand bed casting points by means of the overhead crane.

After pouring, and after the castings reach solidification, the moulds are knocked out in the vicinity of the knocking-out grid, and the sand then passes through the plant and eventually arrives in a re-prepared condition to the hoppers situated over the moulding machines, for use once more.

All castings made on this plant are cast in green sand. If, however, dried sand moulds had to be used, portable mould dryers or stoves would be necessary and the lay-out would be completely different.

For such lay-outs as these, overhead cranes or mechanical lifting appliances are absolutely essential, as they are the only practical methods of transporting heavy moulds and castings of varying dimensions.

Heavy Foundry.—The castings made in this foundry (Fig. 2) range in weight from 1 to 35 tons each.

Some of the moulds are made of brick and loam, but in the main they are made of dried sand, are very heavily cored, and of a very intricate nature.

All this sand has to be reconditioned and as it includes large, hard lumps, which have to be broken down before reconditioning, a special type of sand breaker has been installed.

There is a very large stationary knocking-out grid to deal with sand from the largest boxes. The other items in this plant are the magnetic separator, hexagonal rotary screen, 50-ton storage hopper, 15-tons-per-hour continuous sand mill, disintegrator, and two 10-ton hoppers, from which finished sand in good moulding condition can be drawn. In addition there is a new sand hopper with a capacity of 10 tons, with all the necessary sandfeed belts, elevators, &c.

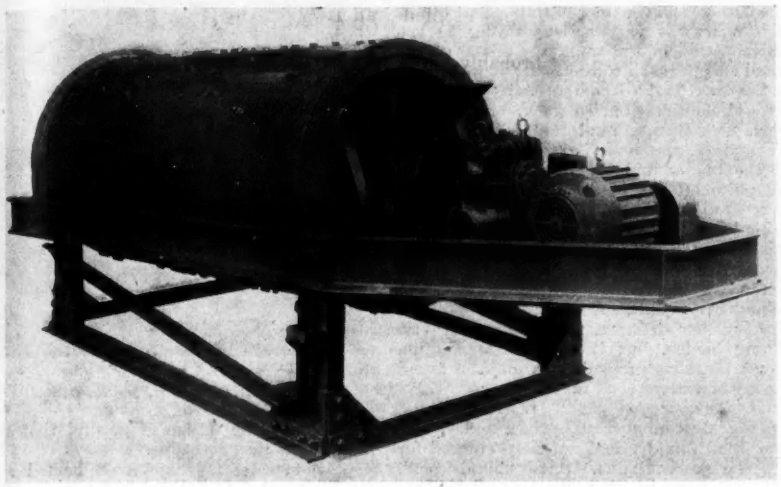


FIG. 3—*Sand Crusher (External View) Installed in Heavy Foundry*

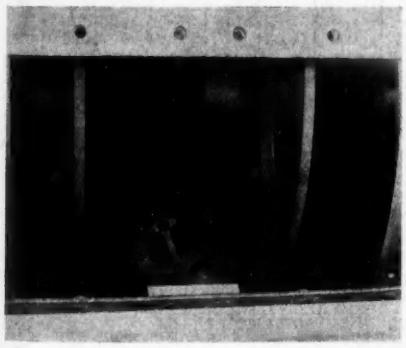


FIG. 4—*Sand Crusher (Internal View)*

The ramming up of these very large moulds is carried out mainly by the use of a tractor type of sand slinger of American design.

The installation is served by powerful overhead cranes, and the entire plant gives every possible satisfaction.

Sand Crusher.—This machine (Fig. 3) is composed of an outside stationary cylinder, with a chute, into which the sand is introduced. Inside this cylinder is fitted a main shaft on to which are bolted a number of retaining discs, whose main function is to keep the loose crushing ball in between each disc from travelling laterally.

The sand is introduced into the chute and as the discs rotate on the shaft the sand, in a lumpy condition, is directed forward to come into contact with the crushing balls, which reduce the lumps to grain size. The sand therefore travels forward and is evacuated at the end of the drum, whence it is reintroduced into the sand system.

Fig. 4 shows the inside view of the machine, which operates very efficiently and effects much saving in sand.

Mechanical Sand Rammer.—The type of machine shown in Fig. 5 is the British counterpart of a type that originated in the United States, and differs fundamentally and in details from it. The official name of the United States machine is the sand slinger, whereas the British machine is called the sand rammer.

One of the many points of difference is that it is believed in Great Britain that the machine should not be portable, but stationary, unless the portable machine possesses its own hopper or bunker from which it can obtain a supply of well prepared and conditioned moulding sand.

Further, all foundries making fairly large castings, suitable for moulding with this machine, must possess overhead cranes and, consequently, it is probably easier to take the job to the machine than the machine to the job.

Moreover, the machine operates at such a speed that it has been found from actual experience that in order to obtain a uniformly rammed mould, it is essential to have a regular and continuous flow of sand to the head of the machine and that this sand must be free of all "foreign" matter, particularly metallic inclusions. When the provisions possible in the portable machine are not present, a large packet of sand is fed into the head of the machine and is rammed into the mould, then for a few moments very little or no sand arrives, during which time the impeller is thrashing air, until a further supply of sand arrives. Such conditions result in unevenly rammed moulds.

Apart from this there is always a danger when taking a supply of sand from the foundry floor that a runner or git or some other piece of metal will be included in the sand and, as this will without doubt get into the impeller head, the result would probably be that some vital part of the machine would be smashed and quite possibly the operator might be injured.

The sand rammer or sand slinger is the only machine at present on the market which can successfully deal with jobbing work, or large castings which are too big for the average moulding machine.

Throughout the world hand moulders are scarce, and, consequently, wages are high. Apart from that aspect, however, the highly skilled man should not be used for the hard donkey work of shovelling sand into a moulding box and the long and tedious work of ramming up large moulds. The skill of the hand moulder should be used to draw the pattern or to do any patching to the mould, which is inevitable when a wooden pattern is used, as is usual in jobbing work.

The skilled man should also supervise the core-setting and closing of the moulds and

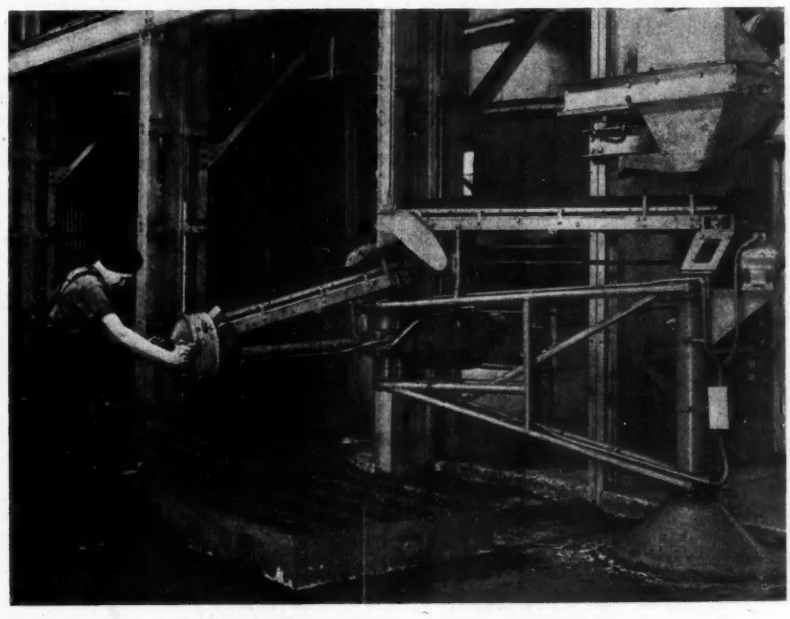


FIG. 5—*Mechanical Sand Rammer (External)*

generally finish the moulds ready for pouring. The machine should be left in the hands of an unskilled or semi-skilled man, who has only to guide the head over the box to solidly ram up the mould.

Thus, apart from the fact that this machine is a great time saver, it also is a great labour saver, and frees the skilled moulder for

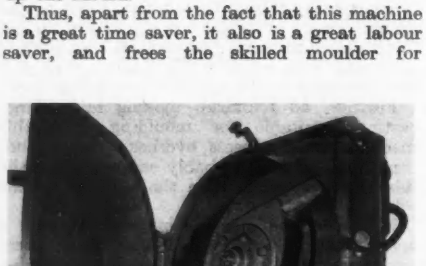


FIG. 6—*Sand Rammer (Internal)*

a much more important section of moulding, where his skill can be displayed to the utmost. It is so elastic that it is absolutely indispensable in any jobbing foundry or for special work, such as for standard items of large size castings.

Fig. 6 shows a fundamental difference between the United States sand slinger and the British sand rammer. The head of the United States machine is fitted with a drum carrying one cup or impeller revolving at a very high speed, which flings the sand into the mould at high velocity. It was found, however, that by reason of the shape of the cup the sand was thrown at a slight angle into the mould and, moreover, that there was quite a considerable amount of spillage of loose sand into the moulds, which tended to result in uneven ramming.

Further experiments were therefore made in Britain, with a number of flat blades to replace the single cup and a great improvement in the regularity of ramming was obtained, in fact, with the plural blades the ramming is quite uniform.

It is also found possible to deal with a much larger quantity of sand with this machine than with the one with a single cup and thus the capacity is greatly increased, without increasing the dimensions of the actual head.

Apart from the above advantages, the wear on the cup and on the liner of the United States sand slinger was very serious owing to the abrasive action of the sand, the shape of the cup and its approach to the sand, which meant that the cups had to be replaced every eight hours and the liners once a week.

With the British multiple-bladed type of sand rammer, the wear is very much less on both the blades and the liners and, as wear takes place on the blades, all that is necessary is to undo the screws, regrind the top of the blades and replace them. The blades, which are made from ordinary mild steel, last for from two to three months, and the liners, which are made from high-tensile steel, last for about five to six weeks.

The impeller drum in Fig. 6 has only two ramming blades, but the patent application covers a plurality of blades, as may be found necessary for larger sizes of head.

Sand Rammer for Small Works.—Fig. 8 shows the latest innovation to the foundry.

The small foundry had not been catered for up to the present time. Small foundries all over the world have had to make their living by making one or two castings off comparatively small patterns. Their only solution being to ram up such moulds by hand.

With the size and type of sand rammer shown in Fig. 8, small foundries will be able to utilise a mechanical ramming agent, and even for larger quantities of varying patterns, this machine can put them in a very good position to compete with the larger and better fitted up foundry. The machine has only

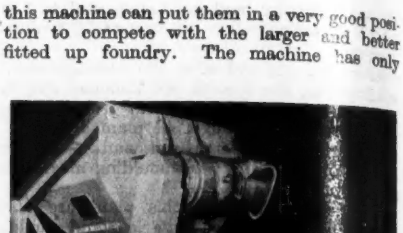
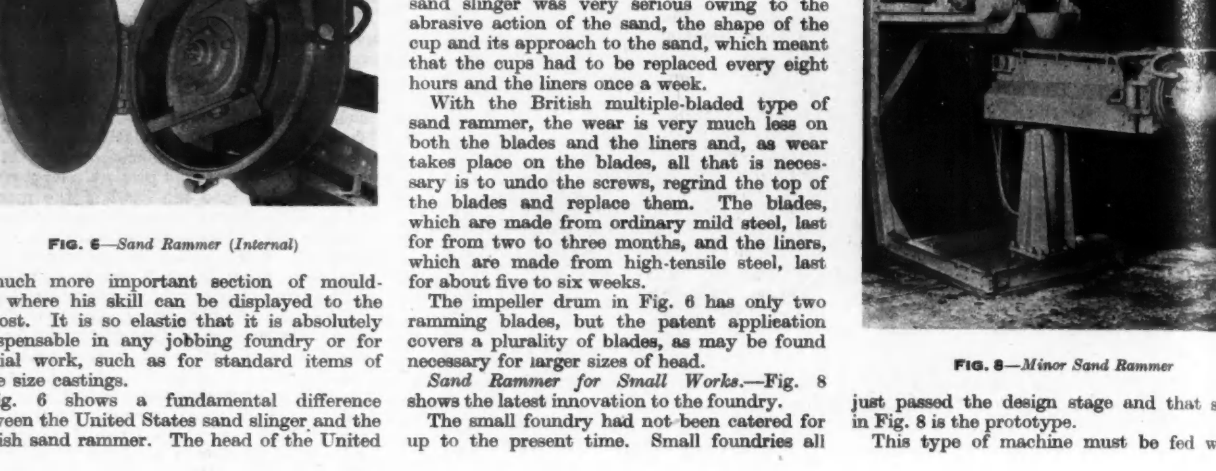


FIG. 8—*Minor Sand Rammer*

just passed the design stage and that shown in Fig. 8 is the prototype.

This type of machine must be fed with a continuous and regular supply of well-conditioned and clean moulding sand to procure the best results; part of it therefore comprises a feeding hopper, containing approximately 4 cwt of sand. The belts are controlled by push-buttons from the head of the machine and, as the top belt is situated directly under the top hopper, as soon as it starts to rotate,



1 Knocking-out grid and chute
2 Belt
3 Magnetic separator
4 16in elevator
5 Rotary screen
6 50-ton hopper
7 Sand bin mill, disc feed
8 Chute under base
9 Vee plough
10 3-ton hopper
11 Automatic sand rammer, 10ft arm
12 Automatic sand rammer, 15ft arm
13 Conical hopper and gate
14 Vibratory screen
15 Rails
16 Minor sand rammer (mobile)
17 Minor sand rammer (stationary)
18 Existing cupolas
19 New cupolas
20 New cranes
21 Weighing machine
22 Lift
23 Platform
24 Rotary furnace
25 Coal-dust platform
26 Sand bins
27 Lift entry
28 Lift exit
29 Existing plant
30 New rammer

FIG. 7—*Layout of Completely Mechanised Jobbing Foundry*

a predetermined quantity of sand is fed down on to the lower belt, and this in turn feeds into the head of the machine, which is fitted with a multiple-blade impeller to fling the sand at high velocity into the moulding box, thus ramming the sand securely and evenly around the pattern.

The ramming arm swivels round at approximately 200 deg., and has also a backward and forward travel of 2ft 6in, so that it can deal with all sizes of moulding box up to approximately 36in by 24in.

This machine has a very interesting field in regard to cores; for very small cores probably the core blower is the most useful machine, provided that there are sufficient cores to be made of the same design and type, but the use of the core blower demands that core boxes must be specially constructed, and hence the core blower is only useful for core making when large repetition quantities are needed. The minor sand rammer, on the other hand, does not need special core boxes and, consequently, it can ram up all cores up to 36in by 24in, whether for jobbing or repetition work. The minor rammer also shows great advantage over the core blower, for large-size cores, for either jobbing or repetition work.

Completely Mechanised Jobbing Shop.—Fig. 7 shows to what extent mechanisation can be carried out in a jobbing foundry.

The work to be made in this foundry consists entirely of jobbing work, ranging from 1 lb up to 2¼ tons in weight. Some of the castings have to be made in green sand and quite a number of the larger ones in dry sand. There are, therefore, three problems: small green sand work, medium green sand work and heavy dry sand work.

Each of these requires a different type of sand, and, consequently, three sand plants are installed. In the small green sand bay a minor sand rammer, running on a track, is installed. and is fed from the batch sand mill and plant. This machine goes up and down the track, ramming up moulds on either side of the track and returning to the inclined belt feeder on the sand plant each time it needs a further supply of sand.

The medium green sand moulds are made by the three "Linslade" sand rammers in the long green sand bay, and the sand is knocked out over the grids, after the moulds are cast, and returned to the plant for reconditioning and resupply to the various sand rammers at the moulding stations.

The dry sand work is moulded up by the two "Linslade" sand rammers, one of which is fitted with a 10ft arm and the other with a 15ft arm, for very large work.

After moulding the moulds are transferred to the drying stoves and the dried moulds are then brought back to the pouring floor for coring up, closing and pouring. They are then again knocked out over the grids indicated and the sand travels back to its own special plant for reconditioning and eventual return to the sand rammers for re-use.

No moulds are rammed by hand and all the arduous and heavy work hitherto carried out by hand is entirely cut out.

Overhead cranes deal with the transport of moulds, moulding boxes, metal, &c. The cores are rammed up by the minor sand rammer and are then placed in the stoves for drying.

The metal is melted in three cupolas, each with a capacity of 3 tons of metal per hour, and a pulverised-fuel rotating-furnace is installed for the supply of any special mixtures of metal.

STUD WELDING DEMONSTRATION.—We recently attended a demonstration of Nelson stud welding, held by Crompton Parkinson, Ltd., Crompton House, Aldwych, London, W.C.2. The process is American in origin and is being developed in this country by Crompton Parkinson, Ltd.; it involves the use of the Nelson stud-welding gun and control box, a stud being loaded into a chuck in the gun and then welded directly to a metal plate. The many applications of the method, for instance, in shipbuilding and in constructional engineering, were pointed out at the demonstration. A description of the process was given in our issue of October 25, 1946, page 371.

Virtues of Standardisation*

THE concept of industrial standardisation, like many other ideas of far-reaching social significance, had its main origins in this country. The merchant and craft guilds of the Middle Ages evolved standards of quality. Their motive was to ensure their own security; the effect was to give the purchaser assurance of serviceability. Our nineteenth century industrialists, too, for all their real and alleged shortcomings, took pride in making good things. They taught the world to accept "British-made" as meaning "well-made." In other words, they also had standards.

The beginning of our own century saw the formation in this country of the world's first national standards movement with a much wider objective—to cut out waste, to produce more goods from given machinery and manpower, so that these goods could be sold more cheaply and their market extended in consequence. So early, therefore, in the century as 1901, the declared purpose of the British standards movement was—as we would say now—increased productivity at lower cost. The British Standards Institution to-day seeks the same objective, though now its work covers the whole tapestry of British industrial activity. What is more, standards bodies in all the other important industrial countries of the world have been fashioned on the British model.

The general arguments in favour of standards have been so frequently expressed and exemplified that there is little, if anything, which is new to be said. The subject is very fully documented. For those who can see—or have already seen—the possibilities, the ways and means are well displayed. Notably, the Lemon Committee found that in many branches of the engineering industry there were too many varieties of products for the same purpose. It quoted as axiomatic that unnecessary variety lowers manufacturing efficiency, and that the effects extend from the raw material right through production and distribution to the consumer. Among reasons for this excessive variety, the Committee held that industry had often failed to appreciate how great an increase in productive efficiency could result from a reduction in the number of types produced, when this reduction was accompanied by the use of modern techniques and equipment. It must also be recorded that another important influence was the insistence of users on minor variants. The Lemon Committee did, therefore, criticise—impartially, I hope—both engineering producers and the consumers they serve for not fully seizing the benefits which could be expected through standardisation in cutting costs and thus restraining prices, with residual benefits spreading all along the line of our industrial activity. In other words, I would say that the Committee found here an attitude of mind.

Now let us consider the second of the two publications I have mentioned—the report of the Study Group sent to the U.S.A. by the Anglo-American Council on Productivity to investigate the American industrial practice of "simplification"—i.e., the process of reducing the number of types and varieties of products made or called for within a definite range. The Group was especially concerned to investigate the effect of that practice on productivity and costs, and the extent to which similar methods could be applied beneficially in this country. Here was revealed, I submit, a different attitude of mind.

The report records that the Group was "greatly impressed by the enthusiasm for high productivity and low cost displayed at every level in American industry." If the American manufacturer can standardise on three types of product instead of twelve, he engineers to obtain such major production economies that his salesman is able (and generally prefers) to "sell" the customer on the advantages of low price and assured delivery, rather than on this or that distinguishing feature—and the customer, in his turn, uses those factors to his own advantage. However, comparison between trans-Atlantic methods and our own is rarely a popular pastime, and, indeed, the Study Group, whose report I have been quoting, recognised that there are good reasons for adapting those American techniques that suit our conditions rather than adopting them all just because they have been proved to work over there.

To my mind, the important point which emerges, in relation to our immediate purpose of maximising dollar exports, is that our customers in North America understand and accept sensible standardisation as part of what may be called their "cost-conscious psychology." On their own record and usage, they want the best possible ratio between price and quality; they expect a manufacturer to apply standardisation of parts, and simplification of ranges, to achieve the best ratio. Needless to say, the buyer will still try to get both maximum individuality in the product he buys and the lowest price. But he well understands that the two are generally in conflict, and in so far as any generalisation is true, he will normally go for intrinsic, measurable value.

So far I have concentrated on the benefits to be derived from standards in securing lower cost—through greater productivity. I have done so for the obvious reason that, apart from any consideration of the price factor in sales, we cannot expect, with the large defence programme now before us, to maintain—let alone increase—our export performance unless productivity can be further and substantially improved.

I must here emphasise, too, what has so often been stressed—and exemplified—before: namely, that productivity improvement through standardisation and simplification relates not only to labour-saving on the factory floor itself, but also to the operations throughout the chain. It covers:

(1) Economy of raw materials.

(2) Easier replacement and maintenance; simpler and more effective quality control.

(3) Reduction of stores lists (of special importance where stocks of spares must be maintained overseas).

(4) Simplification of correspondence and quotation.

(5) Economy of design work.

The last clearly is of great significance at this time. By specifying standard parts and fittings we can save for better purposes the time of our designers, draughtsmen and other creative personnel—the most valuable manhours of technical skill we possess. I would make a similar claim about the benefits which accrue to top management itself by relegating to the field of routine those problems which should be solved beforehand for uniform routine treatment in day-to-day administration.

I am far from wanting to claim that standardisation, simplification and all that is a panacea for every production and sales problem. I do assert, however, that its benefits, especially to a country which is faced with our output problem, are of crucial importance and a long way yet from being fully realised. Nor can we afford either to "ride-off" the argument on grounds of flexibility, of avoidance of rigidity in the interests of further research, or of the specialised demands of certain export customers.

On this very subject of flexibility and further technical development, let it not be overlooked that an intention to standardise immediately focuses attention on a product and its uses. It causes research to be objectively directed—often with quite astonishing results. The relationship between research and standardisation consists of finding the best way of doing a thing and then doing it that way—until a better way is discovered.

I will quote from a very recent and authoritative paper presented to the Institution of Electrical Engineers:

"The policy of creating standards, which leaves the way open for further research and development, is undoubtedly right, and is endorsed by this country's trade in electrical goods (and I would mention that the electrical engineering industry has long been in the forefront of standards work). In 1938 the electrical manufacturing industry became the largest exporter of electrical goods in the world, and ten years later in 1948 it had doubled the

*Dollar Convention, Eastbourne. March 2nd. Abstract of speech by H. A. R. Binney.

quantity exported in 1938. That result would not have been achieved without the standardisation already effected, but much more will be possible with still more standardisation."

If we can agree that benefits of this order must be seized to the maximum practicable extent if the production of this country is to keep pace with the new requirements, we shall still have, of course, to face the possibility that the standardisation set-up we may have decided upon will not always fit the overseas customer's requirements. Clearly, this is where commercial judgment is called for, indeed, and sometimes it will be fine commercial judgment.

The importance of standards to our overseas trade is demanding increasing activity by the B.S.I. at the international level. This work is energetically pursued in the broad interests of securing, first, that British standards are used to the maximum extent possible overseas, and, secondly, that overseas standards so far as we are able to ensure are adapted to fit in with British practice. Close collaboration exists between the U.K. and the Commonwealth countries and many of the standards adopted in these countries have been based on, and even in a number of cases have simply reproduced, the British standard. Many of the more important aspects of the work of the B.S.I. in connection with the importance of standards to our overseas trade are carried through in conjunction with the following two bodies:—the I.S.O. (the International Organisation for Standardisation) and the I.E.C. (the International Electro-Technical Commission).

If I may recall for a moment those earlier times, when we had the lead in engineering exports, standard British components were widely accepted abroad—even despite the use of the metric system in continental countries. In those days British manufacturers could be content to standardise for export on a purely national basis. But this convenient state of affairs changed with rising competition from other countries, and, for example, with the increasing need for accuracy of definition, major deviations from British standards arose in the metric countries. The present active participation of the B.S.I. in the work of the I.S.O. is important in trying to bring these international standards into line again, and so to facilitate the export of standard articles, such as hand tools.

Unfortunately, there was until comparatively recently no corresponding attempt to co-ordinate standards within the inch system of measurement, i.e., mainly between this country and North America. This attempt is now being made, and the extent to which it may prove successful will be an important factor in helping dollar exports, as well, of course, as in the co-ordination of defence requirements, whence, let it be admitted, the original stimulus derived.

Perhaps the biggest factor in promoting dollar exports through standards would be to establish common performance standards with the U.S.A. and Canada, for there is evidence that tenders are being rejected on minor technical points, which are not related to the intrinsic quality of the products concerned. Here, the B.S.I. can help by ensuring in the first place that adequate national standards are prepared for all likely exports, and, in the second place, by securing recognition of such standards as specific guarantees of performance to overseas requirements; or, alternatively, by arranging, as far as practicable, the alignment of North American and British acceptance tests.

A noteworthy example of this kind of approach to the problem has been the recent United States visit of a B.S.I. delegation to work out a common boiler code as a basis for an international boiler code to be published under the auspices of the I.S.O.

It must not be supposed, though, that the North American countries are always more advanced than we are in the use of standards of performance. There are some fields in which they have no generally accepted rating standards at all. Fork-lift trucks are one important example, for which we expect shortly to have a British standard which will achieve wide recognition.

I fancy that sometimes our manufacturers are handicapped initially by their greater conservatism in performance claims, though in the long run this policy may pay us. In cases like that the publication of nationally agreed British standards for the rating of performance can certainly be a powerful weapon. That has been proved in the past in the case of pumps, for which compliance with the British standard performance tests is recognised throughout the world as an acceptable guarantee of the validity of performance claims.

But in the case of another major product, namely, agricultural tractors, the Americans had established a world-wide code for performance tests in the shape of the so-called Nebraska tests, and here the B.S.I. has taken what seemed the most sensible step by establishing a British standard on identical lines.

The main point which I want to get over here is that there are still many fields of industry where the publication of British standards can provide a hall-mark for British goods of great value in the world's markets. Industry and the B.S.I. might well, I suggest, give more attention than hitherto to the selection of standards projects which will best assist in this way—for our resources do not permit of everything being done at once. To take another example: it would, I think, be generally conceded that the well-known A.P.I./A.S.M.E. standards have done much to give the American petroleum equipment industry the lead it has enjoyed. May it not be that the new B.S. 1500, for fusion-welded pressure vessels, will give to British industry a document—and thence a standard of products—which will rival the long-established codes of the U.S.A. in this field?

I ought not perhaps, in this discusson, to omit some mention of the new service now being provided by the B.S.I. as agents in London of the Canadian Standards Association. Here we have safety requirements in connection with electrical apparatus and equipment which have legal authority and are not matched by British standards, or by normal British practice. The B.S.I. has consequently adopted the most expedient course of providing facilities in this country for the inspection of electrical equipment made in the United Kingdom for export to Canada. In this way we can ensure that it satisfies the C.S.A. testing and approvals regulations, and that British producers can, by using our service, export to Canada with the full assurance that difficulties over acceptance on the other side will not occur. And it may well be that a service of this kind will have to go further than the scope of the present scheme.

Books of Reference

The Architects', Builders' and Civil Engineers' Reference Book, 1950. London: George Newnes, Ltd., Tower House, Southampton Street, W.C.2. Price 63s. net.—The third edition of this comprehensive reference book has been revised and its contents rearranged. It opens with a number of special articles indicating the trends of development, and the information given is divided into twenty-two sections. The special articles include: "Exhibition Architecture," by D. L. Dick, F.R.I.B.A.; "The Ministry of Works," by S. P. Kernahan, B.Sc.; "Training in the Building Industry," by A. L. Peyman; "New Developments in Surveying Instruments," and "Methods of Prefabrication in Large Buildings." The detailed information on the wide range of subjects and materials covered is arranged in the following sections:—Basic Building Materials; Metals and Plastics; Heat and Sound Insulation; Wall, Floor and Roof Finishes; Structural Steelwork and Piling; Reinforced Concrete and Brickwork; Fire Resistance; Metal Windows, Doors and Screens; Special-Purpose Buildings and Equipment; Contractors' Plant; Formwork and Scaffolding; Electric Services; Gas Services; Lighting; Water Supply and Sewage Disposal; Heating, Ventilating and Air Conditioning; Lifts, Escalators and Mechanical Handling Equipment; Cleaning, Washing and Drying Equipment; Kitchen Equipment, and Progress. The information given in the various sections is well supplemented by illustrations and drawings and numerous tables. As in the last edition, each section concludes with a list of the manufacturers of the materials or plant dealt with in the book.

French Engineering News

(From our French Correspondent)

Electricité de France is to finance the construction of a dam in Corsica. With other construction at present in hand, a reservoir capacity of 10 million cubic metres of water will thus be provided for the population of Ajaccio.

* * *

Road construction is going ahead in France, in spite of difficulties, and a new bridge across the Seine, at Tancarville, near Le Havre, is to be built. The new structure will be a suspension bridge with a span of 608m. It will have a roadway 12m wide, between footpaths 1·5m in width.

* * *

The first two 1200kW diesel-driven generator sets of the Sté. Electricité et Eaux de Madagascar are expected to come into service in April. They will be used to supplement the output of the Mandroseza thermal power station and thus provide greater regularity in the distribution of power to Tananarive. Other plans for installing diesel plant are being studied, to supplement hydro-electric production. Two 750 h.p. sets are being considered, for instance, for the Fianorantsoa power station. The company is also undertaking an extension programme to increase production at the two hydro-electric plants at Antelomita.

* * *

The most important hydro-electric reservoir in the Dordogne at Bort (see THE ENGINEER, September 16, 1949, page 303) was flooded at the beginning of this month. The reservoir holds 470 million cubic metres of water, the gravity-arch dam being 120m high and 380m long. The generating plant will consist of two turbo-alternator sets with a combined capacity of 100MW. It is expected that the first set will come into service early next year and the second in 1953.

* * *

Electricité de France has given details of its constructional programme for 1951. It is expected that French electrical production will be increased by 1820 million kilowatt-hours. Work on the Ottmarsheim dam and power station in Alsace on the Rhine will be continued, and two turbo-alternator sets will start generating this year. Two further sets will be ready in 1953.

Work in the Alps is also making good progress and at the Brevieres power station two sets will come into production this year and a third in 1953. The first of the four large Pelton wheel sets at Malgovert will be installed this year. It is also hoped that the tunnel at Aiguebelle, which is about 11,700m long, will be holed through some time this year, but it is unlikely that the turbo-generators will be installed before 1953.

In the Pyrenees a complicated series of dams is being constructed which will enable water power to be generated successively by several power stations. Two of these power stations will produce about 244 million kilowatt-hours annually when they are completed. In the Massif Central important work is also going ahead.

The thermal power station at Gennevilliers, in Paris, should be near completion by the end of the year. The installed capacity of the St. Denis station will be increased by 60MW and that of Arrighi by 100MW.

In the north several other thermal power stations are nearing completion. The second 50MW set at Dieppedalle is nearing completion, and at Yainville a second set, of 50MW, is being installed. A station of 500MW capacity at Nantes is under construction, work on the first 50MW installation being already under way; 100MW sets are now being planned and they will have one or two boilers per set.

* * *

The Saar-Ferngas Company has recently completed it seventh pumping station, which forms part of a scheme for the import of gas from the Saar to France. The first section between the Saar and Nancy will be completed shortly. The conduits will then be extended to Paris.

Industrial and Labour Notes

Iron and Steel Production

The British Iron and Steel Federation has issued this week the production figures of the iron and steel industry for February. The weekly output of pig iron averaged 186,300 tons, which represented an annual output rate of 9,687,000 tons. Production of pig iron in January was at an annual rate of 9,520,000 tons and in February last year at an annual rate of 9,588,000 tons. The Federation says that steel production, which averaged 326,000 tons a week, was at the highest rate ever achieved in the month of February. The annual rate of output in February was 16,952,000 tons, compared with 16,898,000 tons in February last year.

Railway Wages

On Friday last it was stated that agreement had been reached between the London Transport Executive and the three railway unions on wages claims submitted on behalf of those employed on London's underground railways. The settlement makes provision for an increase of about 7½ per cent on existing standard wage scales and—like the agreement between the unions and the Railway Executive—is retrospective to January 1st. It is understood that approximately 20,000 workpeople are affected by the increases, the annual cost of which to London Transport is put at £500,000.

Again, as in the case of the recent settlement with the Railway Executive, the unions acknowledged the imperative need of the fullest co-operation with the London Transport Executive in the elimination of waste of manpower, in increasing efficiency and improving productivity. To that end they undertook to examine any proposals which the London Transport Executive put forward and agreed that necessary action should be taken without delay.

The Universities and Industry

The Anglo-American Council on Productivity has announced that a specialist team is to leave this week for a visit to the U.S.A. to study the relationship between universities and industry in that country. The team includes a Vice-Chancellor and three professors from universities in the United Kingdom, the secretary of a University Appointments Board, two principals of technical colleges, four representatives of industrial management, a representative of the Ministry of Education and a representative of the education department of the Trades Union Congress. Dr. Percy Dunsheath, chairman of Convocation, University of London, and director of W. T. Henley's Telegraph Works Company, Ltd., is to lead the team. Among the subjects which the team proposes to study in the U.S.A. are the education of graduates and their employment in industry, the interchange of staff between universities and industry, and the provision of research facilities. The investigation will relate not only to scientists, engineers and other technologists, but to men and women from all faculties at both graduate and post-graduate level.

Aluminium Scrap Prices

The Minister of Supply has made the Aluminium Scrap Prices Order (S.I. 1951, No. 391), which came into operation on Monday last, March 12th. Its purpose is to discourage hoarding and to stabilise scrap prices so that they are in reasonable relation to the price of virgin metal.

During recent months the prices of aluminium scrap have soared and in certain cases have exceeded the price of virgin ingots. The effect, the Ministry says, has been to encourage speculation and to create an unstable state of affairs, which was threatening the structure of the secondary aluminium producing industry at a time when the demand for secondary metal to meet rearmament and other essential requirements was rapidly increasing.

By the new order, maximum prices per ton delivered to buyer's address have been fixed as follows: new pure aluminium scrap (excluding foil scrap), £105; old rolled pure aluminium scrap (excluding foil scrap), £95; clean aluminium alloy scrap, £90: aluminium turnings, £70. The Order provides a formula for fixing the maximum prices of any grades of aluminium scrap not included in the foregoing list. All prices are subject to reduction for inferior quality or lack of cleanliness, and an additional 2s. 6d. a bag has been allowed for bagging. The Order also requires records to be kept of all scrap transactions, describing the material sold and the price charged.

Pneumoconiosis as an Industrial Disease

The Minister of National Insurance has asked the Industrial Injuries Advisory Council to consider further the method of prescribing pneumoconiosis as an industrial disease under the National Insurance (Industrial Injuries) Act, 1946, i.e., how the classes of insured persons eligible for benefit for the disease should be defined. Pneumoconiosis is at present prescribed in relation to insured workers in a number of occupations, which are known to give rise to a risk of the disease. These occupations include stone and granite quarrying and masoning, sand blasting, pottery manufacture, metal grinding, steel fettling, coal and certain other forms of mining, coal trimming and slate dressing.

The Council's industrial diseases sub-committee, under the chairmanship of Sir Wilfrid Garrett, is reviewing the present method of prescribing pneumoconiosis. It will consider such possible alternatives as prescribing the disease generally for all insured workers, or by reference to occupations involving exposure to concentrations of specified dusts. The committee may also reconsider the definition of pneumoconiosis for this purpose. It is at present defined as "fibrosis of the lungs due to silica dust, asbestos dust or other dust, and includes the condition of the lungs known as dust-reticulation."

Persons and bodies interested in the question of the method of prescribing pneumoconiosis are invited to submit written evidence for consideration. Communications should be addressed to the Council's Secretary, Mr. S. E. Waldron, Ministry of National Insurance, 30, Euston Square, N.W.1, as soon as possible and, in any event, not later than May 1st.

Prices of Industrial Materials

The Board of Trade has stated that its index of wholesale prices (1930=100) rose by 1·9 per cent during February and was, for all articles, at the end of the month, 305·6, compared with 300 at the end of January. The index number for industrial materials and manufactures at the end of February had advanced to 355·6, compared with 345·1 at the end of January.

The Board says that the recent general increase in coal prices will have the effect of raising the coal price index by 6·9 per cent, but as it came into operation on February 5th, its full influence is not shown in the index for the month. Then, on February 21st, there was a general increase in iron and steel prices, arising mainly from the increases in coal and coke prices. The iron and steel price index in February showed an increase of 0·6 per cent and at the end of the month stood at 269·4, but again the full effect of the recent price advances will be reflected in the March index. Among the pig iron items included in the index, the increases in February ranged from 1·8 per cent for refined malleable to 3·7 per cent for No. 3 foundry and forge, while the semi-finished steels went up by about 3 per cent. Percentage increases in the prices of finished steel items are: flat bars, 2·0; heavy rails, 3·9; medium plates, 1·8; heavy ship plates, 2·1; carbon chrome machine quality bars, 1·1.

The index indicates few changes in February among items in the non-ferrous metals group. The price of tin rose by 17·2 per cent, compared with January, but brass ingots, the price of which rose very sharply in the later months of last year, were 12·4 per cent cheaper in February than in January.

British Overseas Trade

Provisional figures relating to the United Kingdom's overseas trade in February were announced on Wednesday morning. They show that exports of United Kingdom goods during the month were valued at £175,400,000, bringing the monthly average for the first two months of this year to £194,900,000, compared with an average for the fourth quarter of last year of £201,100,000, and for the whole of 1950 of £180,800,000. The daily rate of exports in February, the Board of Trade says, was 8 per cent lower than in January and in the last quarter of 1950.

Exports from this country to the U.S.A. in the month of February have been valued provisionally at £10,200,000. The daily rate, although below the high figure reached in the fourth quarter of 1950, exceeded that of January by 4 per cent, though the rate of export in January and February together was 18 per cent below the average for the fourth quarter of last year. Exports to Canada in February have been valued at £7,800,000. The daily rate, in this case, is said to have been 8 per cent lower than in January, making the rate of exports to Canada in January and February 30 per cent lower than in the last quarter of 1950.

Imports into the United Kingdom in February have been given a provisional value of £247,800,000, and although that figure is £50,200,000 below the high January total, it is £30,900,000 above the monthly average for 1950. Re-exports in February were valued provisionally at £7,800,000, making the adverse trading balance for the first two months of this year £139,500,000, that is, a rate of £69,800,000 a month, compared with a monthly average of £29,000,000 in 1950.

The Coal Situation

The latest statement by the Ministry of Fuel and Power on the coal situation in this country records an increase in the production of deep-mined coal last week. The amount raised was 4,404,900 tons and with 209,700 tons from opencast workings, the total output for the week was 4,514,600 tons, compared with 4,596,500 tons in the preceding week. In the first ten completed weeks of this year, total coal output amounted to 44,124,600 tons, compared with 43,037,700 tons in the corresponding period of last year. The statement adds that in the first ten weeks of this year 607,000 tons of coal were imported.

Colliery manpower has continued to increase in recent weeks, and in the week ended March 3rd there were 700,900 wage-earners on colliery books, 287,500 of whom were working at the face. The shifts worked per wage-earner during that week averaged 5·11 and the output per manshift at the face was 3·20 tons. Voluntary absenteeism was 5·36 per cent, compared with 5·23 per cent in the preceding week. In the last four weeks, the Minister of Fuel and Power says, the miners have raised 1,000,000 tons more than they did in the corresponding period in 1950, and if the present rate of increase can be maintained till the end of April, he considers that the target of 3,000,000 extra tons, set at the beginning of the year, can still be achieved.

Inland coal consumption in the week ended March 3rd, amounted to 4,474,000 tons, and 169,000 tons were required for exports and bunkers, giving a total consumption for the week of 4,643,000 tons, compared with 4,649,000 tons in the preceding week. Distributed stocks in the week ended March 3rd amounted to 9,779,000 tons, compared with 10,665,000 tons in the corresponding week of 1950.

Notes and Memoranda

Air and Water

THE SHIPBUILDING CONFERENCE.—At the annual general meeting of the Shipbuilding Conference, held in London on March 8th, Mr. J. Ramsay Gebbie, of William Doxford and Sons, Ltd., Sunderland, and Mr. Charles Connell, chairman of Charles Connell and Co., Ltd., Scotstoun, were re-elected president and vice-president, respectively, for the year 1950/51.

SHIN HYDRO-ELECTRIC SCHEME.—The information given by the North of Scotland Hydro-Electric Board on the Shin Scheme, which we published last week, has now been amended. The installed capacities of three of the power stations are now given as: Tirry, 3·5MW; Cassley, 7·5MW and Fiag, 2MW, instead of 1·75MW, 3·75MW and 1MW, respectively.

THE 1951 S.B.A.C. DISPLAY.—The twelfth Flying Display and Exhibition organised by the Society of British Aircraft Constructors will be held at the Royal Aircraft Establishment, Farnborough. The Ministry of Supply has lent, from September 11th to 16th next, Farnborough airfield to the S.B.A.C. for the duration of the display and the public will again be admitted during the last two days.

OCEAN MONARCH.—The new Furness Withy liner, "Ocean Monarch," is nearing completion at the Walker yard of Vickers-Armstrongs, Ltd., and will go on trial towards the end of this month. She will sail for New York on April 17th and will make her maiden voyage to Bermuda on May 3rd. The vessel is expressly designed for cruising to the West Indies and has accommodation for about 430 passengers in one class.

HELICOPTER SERVICE.—The Ministry of Civil Aviation has announced that, after March 31st, the Cardiff-Liverpool service of British European Airways will no longer be operated by helicopters. In order to obtain data under different traffic conditions, a daily passenger service between London and Birmingham will be opened by the British European Airways Helicopter Unit at the beginning of the summer and will continue into next winter.

RADAR WEATHER WATCH.—The use of radar to detect approaching squalls while working cargo enables hatches to be closed in time. Similar use by a ship at sea can save time in port. The Marconi International Marine Communication Company, Ltd., reports that the crew of the "Irish Cedar," which had her hatches opened up at sea, obtained early warning of imminent rain by this use of radar and was able to cover up the hatches and so keep them dry, ready for a grain cargo.

LLOYD'S REGISTER WRECK RETURNS.—Lloyd's Register of Shipping wreck returns for the quarter ended September 30, 1950, show that thirty-seven steamers and motorships, of 49,327 tons gross, were totally lost, due to casualty. Four of the ships, representing 16,817 tons gross, belonged to Great Britain and Northern Ireland. Ships broken up through causes other than casualty totalled ninety-three, of 264,719 tons gross, of which ninety, representing 259,579 tons gross, were steamers and motorships and twenty-four of these ships, totalling 70,546 tons gross, were owned in Great Britain and Northern Ireland. The gross reduction during the quarter, from all causes, in the world mercantile marine was therefore 130 ships, having a gross tonnage of 314,046.

Miscellanea

A HIGHWAY SURFACING MACHINE.—In our issue of last week it was stated, on page 330, that the rate of working of the highway surfacing machine developed by the Metropolitan Construction Company, Ltd., was about 100 square feet per day. This figure should have been 100 square yards per day.

THE SWISS INDUSTRIES FAIR.—The Swiss Industries Fair will be held at Basle from April 7th to 17th. It is stated that more than 2000 exhibitors will participate, their displays covering a floor space of about 1,000,000 square feet. Details of the Fair can be obtained from the commercial section of the Swiss Legation, 18, Montague Place, Bryanston Square, London, W.1.

THE LATE MR. F. A. FROST.—We have learned with regret of the recent death of Mr. Francis Aylmer Frost, at the advanced age of ninety. Mr. Frost had an unbroken connection, extending over seventy-one years, with the firm of Peter Stubs, Ltd., Warrington, from the board of which he retired two years ago. He was the last direct descendant of the original Stubs family to be connected with the management of the firm.

"THE OLD N'IONS."—"The Old N'ions," the past students' association of Northampton Engineering College, St. John Street, London, E.C.1, has issued a calendar of its forthcoming functions and giving also the names of officers. This year's president is Colonel John Reading, M.I.E.E., of the engineer-in-chief's department, General Post Office. The honorary secretary of the association is Mr. A. N. D. Kehr, 421, Grand Buildings, Trafalgar Square, W.C.2, from whom copies of the calendar may be obtained.

THE INSTITUTE OF PHYSICS.—The Institute of Physics has stated that the fifth annual conference of the Stress Analysis Group will be held on April 4th, 5th and 6th, at the Mechanical Engineering Department of the University of Liverpool. The programme includes, during the first day, the annual general meeting of the group and the opening lecture by Professor D. G. Christopherson on numerical methods in stress analysis. During the second day there are three lectures, dealing with applications of the electric strain gauge to stress analysis, and one by Dr. D. G. Sopwith on fatigue stresses. The conference will conclude with four lectures, mainly concerned with photo-elastic methods in stress analysis.

RAPID STEEL-FRAMED BUILDING CONSTRUCTION.—Chamberlain Industries, Ltd., Staffa Works, Staffa Road, Leyton, London, E.10, is now producing steel-framed buildings of unit construction, designed to facilitate rapid and easy assembly. They can be provided in widths of 36ft, 48ft and 60ft. The trusses are placed at 10ft intervals, enabling any reasonable length of building to be constructed, and the height can be adjusted as required from 12ft to 18ft. The steelwork, consisting of stanchions, trusses, purlins, sheeting rails and gable ends, forms a complete structure with all the necessary bolts, cleats and connections. Corrugated asbestos sheeting and all necessary accessories are also provided.

SUBMERGED HYDRO-ELECTRIC POWER PLANTS.—The Technical Information and Documents Unit of the Board of Trade has released details of two microfilm strips of reports on submerged hydro-electric power plants built in Bavaria. The first is by Dr. A. Menge, and the second by Dr. Otto Kirschmer, the text of both being in German. Both reports review existing installations and outline the disadvantages of this type of plant, and Dr. Menge comments on the injury done to Bavaria by the compulsory adoption of this system. Information on these microfilms may be obtained from the Technical Information and Documents Unit of the Board of Trade, Lacon House, Theobalds Road, London, W.C.1; the references are FD 105/51 and FD 106/51.

A HIGH-SPEED STEEL SCRAP COLLECTION SCHEME.—A collection scheme for high-speed steel scrap has been inaugurated by Clarkson (Engineers), Ltd., of Nuneaton. This company is approaching users of 18 per cent tungsten high-speed steel tools in an effort to start a national effort to ensure that worn-out milling cutters are returned to the steel-makers through a department opened at its works. With this object in view special posters have been printed and are being distributed by the firm at its own expense. These posters are intended for use in conjunction with scrap boxes in workshops, and they call the attention of workers to the need for salvaging valuable scrap metal in the form of worn cutters. Firms interested in the scheme can obtain particulars and posters from Clarkson (Engineers), Ltd.

MOND NICKEL FELLOWSHIPS.—Applications are now invited for the award of Mond Nickel Fellowships for 1951. The main object of the Fellowships is to enable selected applicants of British nationality and educated to university degree or equivalent standard to obtain additional training and wider experience in industrial establishments, at home or abroad, so that, if they are subsequently employed in executive or administrative positions in the British metallurgical industries, they will be better qualified to appreciate the technological significance of research and to apply its results. There are no age limits, though awards will seldom be made to persons over thirty-five years of age. Each Fellowship will occupy one full working year. It is hoped to award five Fellowships each year of an average value of £750 each. Applicants will be required to define the programme of training in respect of which they are applying for an award, as well as particulars of their education, qualifications and previous career. Full particulars and forms of application can be obtained from the Secretary of the Mond Nickel Fellowships Committee, 4, Grosvenor Gardens, London, S.W.1. Completed application forms must reach the committee not later than June 1, 1951.

Personal and Business

MR. R. L. PRAIN has been elected a director of The International Nickel Company of Canada, Ltd.

MR. J. D. SUTCLIFFE has been appointed commercial director of Richard Sutcliffe, Ltd., Horbury, Wakefield.

GENERAL REFRACTORIES, Ltd., Sheffield, states that Mr. Donald Morris has been appointed secretary in succession to the late Mr. James Walker.

NEWMAN INDUSTRIES, Ltd., states that Mr. E. R. A. Milne, A.M.I.E.E., formerly an assistant sales engineer in the Manchester area, has been appointed branch manager for Scotland at the company's Glasgow office.

LIEUT.-COLONEL AUSTIN G. BATES has been elected to succeed Sir Guy Ropner as chairman of the General Council of British Shipping; Mr. C. E. Wurtzburg and Viscount Runciman were elected joint vice-chairmen.

PETER STUBS, Ltd., Warrington, has extended the territory of its London representatives, Messrs. Sellers, 6, Southampton Place, W.C.1, to cover the whole of Kent and Surrey and the counties of Sussex, Berkshire and Hampshire.

THE MINISTER OF CIVIL AVIATION has appointed Mr. S. Kenneth Davies, C.B.E., to be a part-time member of the board of British European Airways Corporation for a period of three years, from March 12th. He is chairman of the Welsh Advisory Council for Civil Aviation.

ARMSTRONG-WHITWORTH AND CO. PNEUMATIC TOOLS, Ltd., Gateshead-on-Tyne, has been acquired by Independent Pneumatic Tool Company, Aurora, Illinois, U.S.A. Mr. R. G. Faverty, formerly manager of the Independent Company's branches in Chicago and Detroit, has arrived in this country to take charge of the new subsidiary as managing director.

THE TELEGRAPHIC CONSTRUCTION AND MAINTENANCE COMPANY, Ltd., and Mullard Electronic Products, Ltd., announce the formation of a new company, to be known as Telcon Telecommunications, Ltd. The object is to promote and co-ordinate the development, manufacture and sale of Telcon cables and Mullard equipment associated with land line telecommunications. Mr. J. N. Dean is chairman and Mr. J. P. Jeffcock, vice-chairman, of the new company, the registered office of which is at 22, Old Broad Street, London, E.C.2.

Launches and Trial Trips

NYHOLT, motor tanker; built by the Netherlands Dock and Shipbuilding Company for Hilda Knudsen, Norway; length b.p. 151m, breadth 20·65m, depth 11·11m, deadweight 16,000 tons; Stork-N.D.S.M. diesel engine, six cylinders, 5500 h.p. at 116 r.p.m. Service speed 13·65 knots. Launch, February 24th.

OLAFUR JOHANNESSON, steam trawler; built by Hall Russell and Co., Ltd., for the Icelandic Government; length b.p. 183ft 6in, breadth moulded 30ft, depth moulded to upper deck 16ft; quick-freeze plant and cold storage; triple expansion engine using superheated steam, 1200 i.h.p. Trial, February 27th.

POLARBRIS, motor tanker; built by Barclay, Curle and Co., Ltd., for Melsom and Melsom, Norway; length 566ft, breadth 72ft 6in, depth 40ft 6in; deadweight 19,000 tons; Barclay, Curle-Doxford oil engine, six cylinders, 750mm diameter by 2500mm combined stroke, 8000 b.h.p. Launch, February 27th.

AGUILA, tug and water vessel; built by Philip and Son, Ltd., for the Compania Sud-Americana de Vapores, Valparaiso; length b.p. 110ft, breadth moulded 25ft, depth moulded 12ft 3in, fresh water 160 tons; British Polar diesel engine, 680 b.h.p. at 260 r.p.m. Launch, February 28th.

Contracts

THE BURNTISLAND SHIPBUILDING COMPANY, Ltd., is to build a motor cargo liner of 11,650 tons deadweight for the Power Steamship Company, Ltd., and the propelling machinery will consist of a Hawthorn-Doxford diesel engine of 6600 b.h.p.

HALL, RUSSELL AND CO., Ltd., are to build three self-trimming colliers, each of 4600 tons deadweight, for the North Thames Gas Board, having triple-expansion steam machinery constructed by the North-Eastern Marine Engineering Co. (1938) Ltd.

British Patent Specifications

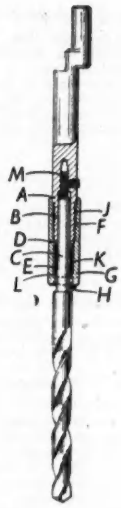
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

MACHINE TOOLS

649,750. October 26, 1948.—Improvements in or relating to Chucks, The Birmingham Small Arms Company, Ltd., of Armoury Road, Small Heath, Birmingham, and Albert Edward Wood, of the company's address.

The chuck comprises a helical spring adapted to surround a drill, and means to cause an axial compression force to be exerted on the spring whereby it is maintained rigid with the chuck and is caused to grip the drill. The accompanying drawing shows a part-sectional elevation of a spindle for a gearless multi-spindle drill head. The chuck body *A* has a bore *B* of a diameter slightly larger than that of the parallel drill shank *C*, for which the chuck is designed. The end of the body is formed as a conical seating *D* for one end of a helical spring *E* and the seating converges towards the mouth of the bore. The exterior of the body is formed with a plain



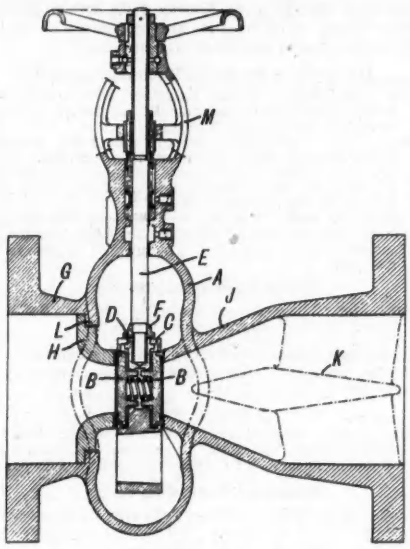
No. 649,750

cylindrical portion extending from the seating for a short distance to a screw-threaded portion *F*, all being relatively coaxial. A hollow cylindrical end cap *G* has at its nose end a bore *H* which has a slide-fit engagement with the drill shank, and at its opposite end is internally screw threaded at *J* to engage the screw-threaded portion on the body. The end cap between the bore and the screw threads is formed with a sleeve-like portion *K*, which is slightly greater than the external diameter of the helical spring *E*, so that it engages the sleeve with an easy slide-fit. A conical seating *L* at the nose end is engaged by the other end of the spring, both the seatings in the body diverging in directions the one towards the other. The exterior of the end cap is provided with flats for a spanner. The ends of the spring are ground flat. A threaded stud *M* in the body serves as an abutment for the back end of the tool shank. When it is desired to grip a tool in the chuck, the end cap *G* is loosened so that the spring is unstrained. When the end cap is rotated so that an axial compression force is imposed on the spring by the seatings *D* and *L* the spring is frictionally locked to the body and end cap and exerts a gripping pressure on the drill, to lock it frictionally in the chuck. —*January* 31, 1951.

HYDRAULIC ENGINEERING

649,187. October 13, 1947.—Improvements in Gate Valves for Fluid-Carrying Conduits, Emile Maurice Demaret, of 35, Chaussée, de Charleroi Fleurs (Hainaut), Belgium.

In the gate valve described the body of the valve and the inflow and outflow pipes are formed of a unit cast in one piece. In the drawing, *A* is the body of the gate valve, *B* are two closure members, between which a spring is located, *C* a collar for the closure members, *D* the collar of the neck of the Venturi passage in the open position of the valve, *E* a control rod and *F* a locking collar for this rod. Inside the admission or inflow pipe *G*, which is of uniform section, is a removable member *H*. The nozzle *H*, which corresponds to the converging cone employed in the case of a Venturi, is of a form which is rationally determined according to the characteristics of the fluid flow desired. As is shown in the drawing, a diverging portion *J*, comprising a flow-guiding deflector *K*, can be provided on the outflow side. The nozzle *H* is screwed into a circular projection *L*. In the assembly of



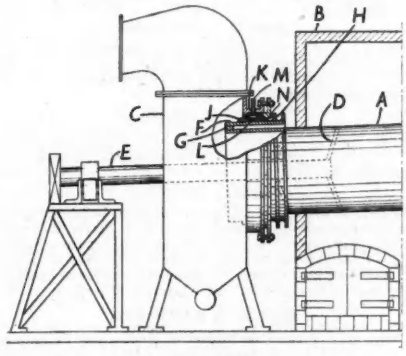
No. 649,187

such a gate valve, it is therefore sufficient to introduce the closure members *B*, together with their collar *D*, into the interior of the body, and the rod *E* is lowered and attached to the collar, after which the nozzle *H* is placed in position. A further feature of the valve is that the converging nozzle forms a seat for the closure members on the admission side. In the arrangement described the body may comprise, in addition, a supporting structure. —*January* 24, 1951.

ROTARY FURNACES

649,561. October 29th, 1948.—An Improved Rotary Retort, James Kean Young, of 123, Eighth Avenue, Maylands, Western Australia, and Ernest Archibald Wright, of 609, Wellington Street, Perth, Western Australia.

In using the ordinary type of rotary retorts in the distillation of pyroligneous material, considerable difficulty is experienced, particularly at the discharge end gland, due to the separation of tarry material at the gland aggravated by the considerable movement which results from the expansion of the retort at this end. These difficulties are claimed to be overcome by the use of the retort described. As shown in the drawing, the retort *A* passes through a heating and combustion chamber *B*, in which the retort is inclined



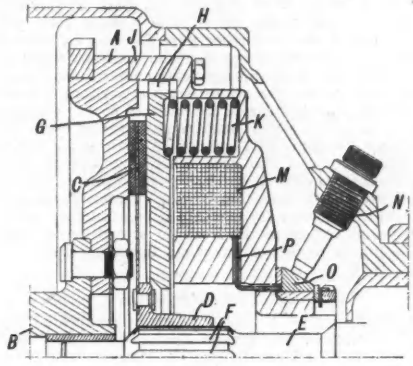
No. 649,561

slightly towards the discharge end. At that end the retort passes through the combustion chamber into a stationary discharge compartment *C*, where a gland is provided. Spider supports *D* inside the retort near the discharge end carry a shaft *E* which extends out through the far side of the discharge compartment and is supported in bearings. At the discharge end of the retort is a long collar *F*, of somewhat greater diameter than the retort, and a bush *G* is interposed between the collar and the retort. An annular air jacket is thereby formed between the retort and the collar. Near the unattached end of the collar is a circumferential trough *H* into which cooling water can be run during operation. At an appropriate intermediate position a flat ring *J* can be welded to the collar to form the actual bearing face of the gland on a gland ring *K* on the stationary discharge compartment *C*. A shoulder in this ring is packed with asbestos or other heat-resisting fibre. In association with the ring there is also a circular channel member *L* which is supplied with steam or other suitable fluid through a pipe *M*. With this construction it is claimed, longitudinal expansion takes place at the high end where there is provision for it being accommodated.—*January* 31, 1951.

ELECTRICAL ENGINEERING

650,174. March 4, 1948.—An Electromagnetically Operated Friction Clutch, The Société Anonyme Française du "Ferodo," of 64, Avenue de la Grande Armée, Paris, France.

The purpose of this invention is to apply the principle of remote control to a clutch mechanism without making the installation elaborate. We illustrate a half-sectional view taken through the axis of the clutch. The driving plate *A* is fixed on the driving shaft *B* and co-operates with the driven disc *C*, which has on either side friction linings. The disc is rigid with a hub *D*, which is slidably mounted on the driven shaft *E* and with which it is made rotationally rigid by means of slots and feathers *F*. As the clutch is thrown into gear the linings on the disc *C* are compressed between the driving plate *A* and a pressure disc *G*, which is shifted parallel with the driving shaft and the driven shaft, for which movement it is guided by the feathers *H* in slots in a cover *J*. Compression springs *K* react

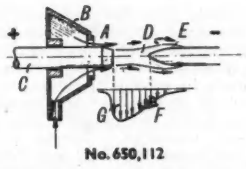


No. 650,174

against the bottom of the cover and permanently urge the movable disc *G* into engagement with the disc *C*. Secured also in the cover *J* is a toric electromagnet *M* energised through the brush *N*, the annular collector *O* and the lead *P*. In the engaged position the power is transmitted through the driving plate *A*, the pressure disc *G*, the linings, the driven disc *C*, the hub *D* and the driven shaft *E*. When current is sent through the winding of the electromagnet the pressure disc *G* is attracted by the electromagnet. The result of the shifting of the disc along the guides releases the friction linings and uncouples the driven shaft. Conversely, if the current is cut off from the electromagnet either by the opening of a switch or by the interposition of an adjustable resistor, the action of the springs becomes predominant and the disc is once more pressed against the linings to engage the clutch.—*February* 14, 1951.

650,112. December 20, 1947.—Direct Current Arc Lamp, Edgar Gretener, of Ottenweg 25, Zürich, Switzerland.

This invention relates to a high-intensity d.c. arc lamp, in which the arc itself is blown or concentrated by means of an air stream. Referring to the accompanying drawings, an air stream *A* is directed through a nozzle *B* on to the positive carbon *C* of an arc lamp in such a way that it confines or concentrates the arc and the arc flame into a



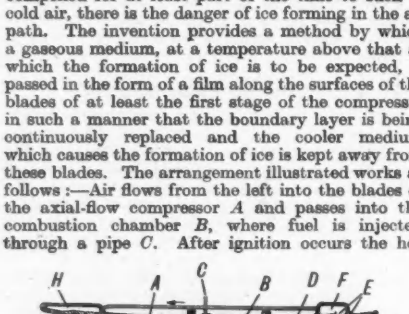
No. 650,112

cylindrical space *D* between the two coaxial electrodes *E* and *C*. The brightness of the luminous cylinder *D* diminishes from the positive towards the negative electrode *E*, as is indicated by the ordinates *F* of the diagram *G*. Various arrangements of mirrors are also described and illustrated in the specification.—*February* 14, 1951.

GAS TURBINES

650,064. February 10, 1948.—Method of and Arrangement for Preventing the Formation of Ice in Axial-Flow Compressors, Aktiengesellschaft Brown, Boveri et Cie., of Baden, Switzerland.

With turbine driven compressors used in aeroplanes and locomotives, where the compressor is compelled for at least part of the time to suck in cold air, there is the danger of ice forming in the air path. The invention provides a method by which a gaseous medium, at a temperature above that at which the formation of ice is to be expected, is passed in the form of a film along the surfaces of the blades of at least the first stage of the compressor in such a manner that the boundary layer is being continuously replaced and the cooler medium which causes the formation of ice is kept away from these blades. The arrangement illustrated works as follows :—Air flows from the left into the blades of the axial-flow compressor *A* and passes into the combustion chamber *B*, where fuel is injected through a pipe *C*. After ignition occurs the hot



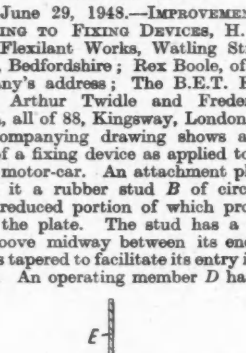
No. 650,064

gases which are produced flow through turbine *D* and do work there. Whilst the main part of the exhaust gases flows straight on, part of them is diverted outwards at *E* and passes into the chamber *F* and a further part flows in an inward direction into the rotor *G*. The one part flows to chamber *H* and through channels to the guide blades *J*, whilst the other part passes through rotor *G*, bore *K*, rotor *L* and channels *M* to the running blades. Both partial exhaust gas streams leave the blades through slits connected with longitudinal channels, as is the case when high-temperature turbines are cooled, and the gas streams cover the blades with a thin film of hot exhaust gases and form a boundary layer which is continuously being renewed and keeps the fresh air stream away from the blades to prevent ice from forming.—*February 14, 1951.*

MISCELLANEOUS

649,463. June 29, 1948.—Improvements in or relating to Fixing Devices, H. G. Miles, Ltd., Flexilant Works, Watling Street, Dunstable, Bedfordshire ; Rex Boole, of the above company's address ; The B.E.T. Federation, Ltd.; Arthur Twidle and Frederick John Gough, all of 88, Kingsway, London, W.C.2.

The accompanying drawing shows a sectional elevation of a fixing device as applied to a bonnet panel of a motor-car. An attachment plate *A* has bonded to it a rubber stud *B* of circular cross section, a reduced portion of which projects into a hole in the plate. The stud has a peripheral annular groove midway between its ends and its outer end is tapered to facilitate its entry into a yoke member *C*. An operating member *D* has one part



No. 649,463

extending axially into the stud and secured by bonding. The other part of the operating member projects beyond the stud through the plate. The attachment plate has its upper portion bent over at right angles to provide a thumb pad to give greater purchase on the operating member to flex the stud. As applied to a hinged bonnet panel *E* of a car the stud assembly is secured to the lower portion of the panel, the stud projecting inwards through a hole in the panel. The yoke member *C* is secured by its legs to the car frame. The dotted lines on the drawing show the relative positions of the stud and operating member when in the free position clear of the yoke, and when the stud is being depressed to enter and engage in the yoke. Alternative forms of the device are described in the specification.—*January 24, 1951.*

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

Association of Supervising Electrical Engineers

Sat., Mar. 17th.—Oxford Branch : Southern Electricity Board's Demonstration Room, George Street, Oxford, "Ventilating," 2.30 p.m.

Mon., Mar. 19th.—Bournemouth Branch : Grand Hotel, Firvale Road, Bournemouth, "Estimating," W. H. Brooks, 8.15 p.m.——Central London Branch : St. Ermin's Hotel, London, S.W.1, "Atomic Energy," J. McCartney, 6.50 p.m.

Tues., Mar. 20th.—Lighting Service Bureau, 2, Savoy Hill, London, W.C.2, "Modern Lighting, including American and Continental Practice," E. B. Sawyer, 6.30 p.m.

British Interplanetary Society

Sat., Mar. 17th.—Central Technical College, Suffolk Street, Birmingham, film show, 6 p.m.

Engineer Buyers' and Representatives' Association

To-day, Mar. 16th.—Works visit to Flower's Brewery, Stratford-on-Avon, 2 p.m.

Engineers' Guild

Mon., Mar. 19th.—N.W. Branch : Grand Hotel, Aytoun Street, Manchester, "Aims and Achievements of the Engineer's Guild," Robert Chalmers, 6.30 p.m.

Illuminating Engineering Society

Tues., Mar. 20th.—Liverpool Centre : Electricity Board's Service Centre, Whitechapel, Liverpool, 1, "Home Lighting," J. N. Aldington, 6 p.m.

Incorporated Plant Engineers

Wed., Mar. 21st.—Western Branch : Grand Hotel, Bristol, annual general meeting, "Gas and Oil Engines," A. C. Yeates, 7.15 p.m.

Thurs., Mar. 22nd.—S. Yorkshire Branch : Grand Hotel, Sheffield, annual general meeting, 7.30 p.m.

Institute of British Foundrymen

Tues., Mar. 20th.—Coventry and District Students' Section : Technical College, Coventry, "Foundry Lay-out and Equipment," J. D. Berry, 7.15 p.m.

Institute of Economic Engineering

To-day, Mar. 16th.—George Hotel, Kingsbury, "The Punched Card System and its Application to Management," John Wm. Parker, 7 p.m.——Engineers' Club, Albert Square, Manchester, "Education for Management," H. E. Kearsey, 7.30 p.m.

Institute of Industrial Supervisors

Wed., Mar. 21st.—W. Bromwich Section : Grammar School, West Bromwich, "Some Aspects of the Operation of Production Control," A. J. Smith, 7.45 p.m.

Thurs., Mar. 22nd.—Newark-on-Trent Section : County Technical College, Newark, "Modern Foremanship," H. R. Harbott, 7.30 p.m.——Rotherham Section : College of Technology, Howard Street, Rotherham, industrial film show, 7.30 p.m.

Institute of Marine Engineers

Today, Mar. 16th.—85, Minories, London, E.C.3, annual general meeting of the Education Group, discussion on "The Future Development of Higher Technological Education and its Effect on the Professional Engineering Society," opened by C. W. Tonkin, 6 p.m.

Institute of Navigation

To-day, Mar. 16th.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "Applications of Oceanographical Research to Navigation," G. E. R. Deacon, 5 p.m.

Institute of Petroleum

Wed., Mar. 21st.—Stanlow Branch : Grosvenor Hotel, Chester, "Origin and Migration of Petroleum," F. Morton, 7.15 p.m.

Institute of Physics

To-day, Mar. 16th.—47, Belgrave Square, London, S.W.1, "The Physics of Radiography," H. S. Peiser, 6.30 p.m.

Mon., Mar. 19th.—47, Belgrave Square, London, S.W.1, "Investigations on the Spectral Character of Spark Sources," D. Kaiser ; "Outline of a Theory of Spectrochemical Evaluation," H. Kaiser, 5.30 p.m.

Institute of Refrigeration

Tues., Mar. 20th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Refrigerated Display," A. C. Murdoch, 5.30 p.m.

Institute of Road Transport Engineers

Mon., Mar. 19th.—Midlands Centre : Crown Inn, Broad Street, Birmingham, "Trends in Design, with Particular Reference to the Commercial Show, 1950," P. M. A. Thomas, 7.30 p.m.

Institution of Civil Engineers

Tues., Mar. 20th.—Great George Street, London, S.W.1, "Notes on Some Mechanical Aids to the Maintenance of Rural Roads," E. C. Boyce, 5.30 p.m.

Institution of Electrical Engineers

Sat., Mar. 17th.—N. Midland Students' Section : Yorkshire Electricity Board Offices, Whitehall Road, Leeds, 1, "Research in Electrical Engineering," K. J. R. Wilkinson, 2.30 p.m.

Mon., Mar. 19th.—Radio Section : Savoy Place, Victoria Embankment, W.C.2, "Radio Astronomy," A. C. B. Lovell, 5.30 p.m.——N.E. Centre : King's College, Newcastle upon Tyne, "The Acoustics of Studios and Auditoria," W. Allen, 6.15 p.m.

Tues., Mar. 20th.—N. Midland Centre : Lighting Service Bureau, 24, Aire Street, Leeds, 1, "Electrically Interlocked Guards on Machines," W. Fordham Cooper, 6.30 p.m.

Tues., Mar. 20th to Sat., Mar. 31st.—S. Midland Centre : College of Technology, Birmingham, Jubilee Exhibition, open daily, 11 a.m. to 8.30 p.m., excluding Good Friday, Saturday and Easter Monday.

Wed., Mar. 21st.—Supply Section : Savoy Place, Victoria Embankment, W.C.2, "Variable-Voltage Generation Applied to A.C. Power Systems," R. L. Chantrill, 5.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tues., Mar. 20th.—39, Elmbank Crescent, Glasgow, C.2, "Alternating Current Supplies for Auxiliary Plant on Board Ship," N. V. Pestereff, 6.30 p.m.

Institution of Heating and Ventilating Engineers

Wed., Mar. 21st.—London and District Associate Members and Graduates' Section : 178-180, Edgware Road, London, W.2, "Engineering Services for Medical Research," V. C. Hardy, 6.30 p.m.

Institution of Locomotive Engineers

Wed., Mar. 21st.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, annual general meeting, "British Standard Locomotives," E. S. Cox, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Mar. 16th.—Storey's Gate, St. James's Park, S.W.1, "Pipe Joints for Hydraulic Power Transmission," B. Cooke, 5.30 p.m.

Mon., Mar. 19th.—Scottish A.D. Centre : Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "The Development of the De Havilland Series of Engines for Light Aircraft," J. L. P. Brodie, 7.30 p.m.

Wed., Mar. 21st.—Midland Branch, Graduates' Section : English Electric Association Hall, Stafford, "The Electrification of Spinning Mills," H. Law, 7 p.m.——Western Branch : Electricity House, Bristol, "Mechanical Handling," A. Roebuck, 7 p.m.——N.E. A.D. Centre : The University, Leeds, "The Development of the De Havilland Series of Engines for Light Aircraft," J. L. P. Brodie, 7.30 p.m.

Institution of Post Office Electrical Engineers

Wed., Mar. 21st.—Waterloo Bridge House, London, S.E.1, "The 2000-Type Selector and its Problems," J. O. Thompson and F. Haythornthwaite, 5 p.m.

Institution of Production Engineers

To-day, Mar. 16th.—E. Counties Section : Public Library, Ipswich, annual general meeting, 6.30 p.m., followed by "Noise and Vibration in Machinery," W. A. Tuplin.——N.E. Graduate Section : Neville Hall, Westgate Road, Newcastle-upon-Tyne, "Work Measurement," W. K. Hall, 7 p.m.

Mon., Mar. 19th.—N.E. Section : Neville Hall, Westgate Road, Newcastle-upon-Tyne, annual general meeting, followed by a film show, 7 p.m.——Manchester Section : College of Technology, Sackville Street, Manchester, annual general meeting, "Foremanship," A. P. Young, 7.30 p.m.

Tues., Mar. 20th.—Luton Section : Town Hall, Luton, "Manipulation and Fabrication of Perspex," W. Edwards, 7.15 p.m.——Coventry Section : Geisha Café, Hertford Street, Coventry, "Mechanical Gauging and Inspection," J. Loxham, 7.15 p.m.

Wed., Mar. 21st.—Birmingham Section : James Watt Memorial Institute, Great Charles Street, Birmingham, annual general meeting and address by the Section President, 7 p.m.——Shrewsbury Sub-Section : Technical College, Shrewsbury, "Some Practical Aspects of Gas Turbine Design," T. L. Gardner, 7.30 p.m.

Institution of Structural Engineers

To-day, Mar. 16th.—Lancashire and Cheshire Branch : College of Technology, Manchester, "Prestressed Concrete in Architecture," L. W. Elliott, 7 p.m.

Tues., Mar. 20th.—Midland Counties Branch : James Watt Memorial Institute, Great Charles Street, Birmingham, annual general meeting, followed by films, 7 p.m.

Wed., Mar. 21st.—Yorkshire Branch : The University, Leeds, "Hydro-Electric Development, Pitlochry," J. Guthrie Brown, 7 p.m.

Junior Institution of Engineers

To-day, Mar. 16th.—39, Victoria Street, London, S.W.1, "Steam Locomotive as a Vehicle," C. R. H. Simpson, 6.30 p.m.——Sheffield and District Section : Grand Hotel, Sheffield, "Notes on the Exploitation of Water Power," W. H. Bailey, 7.30 p.m.

Reinforced Concrete Association

Wed., Mar. 21st.—Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1, "Some Recent Developments in Prestressed Concrete," D. H. New, 6 p.m.

Royal Meteorological Society

Wed., Mar. 21st.—49, Cromwell Road, London, S.W.7, "The Role of Atmospheric Disturbances in the General Atmospheric Circulation," E. Palmen, 5 p.m.

Sheffield Society of Engineers and Metallurgists

Mon., Mar. 19th.—Royal Victoria Station Hotel, Sheffield, "Accountancy as the Servant of Management," R. Peddie, 6.15 p.m.